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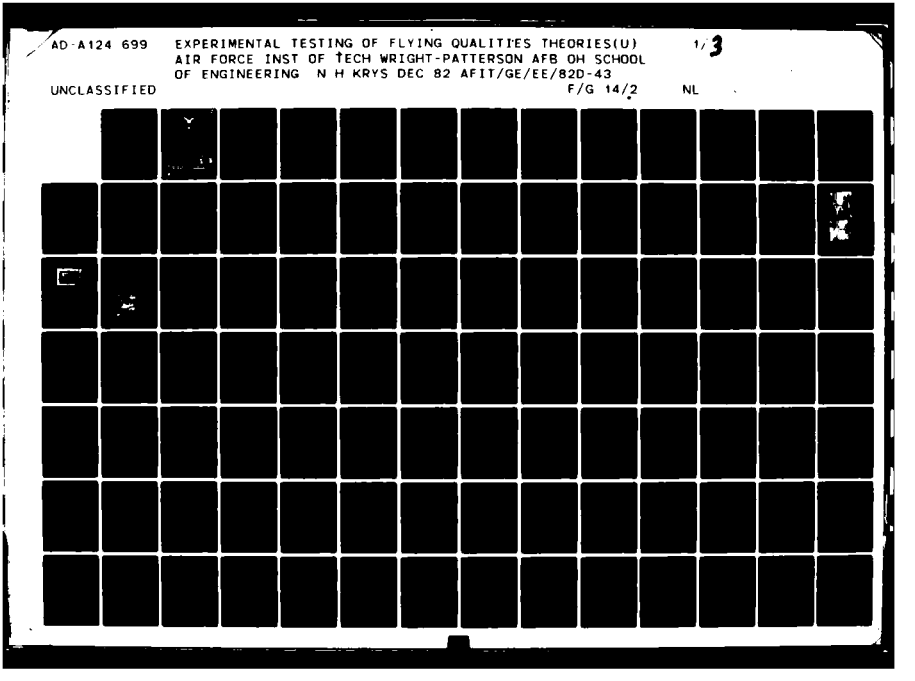

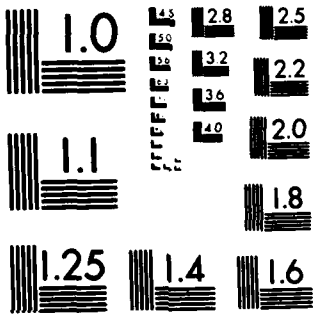

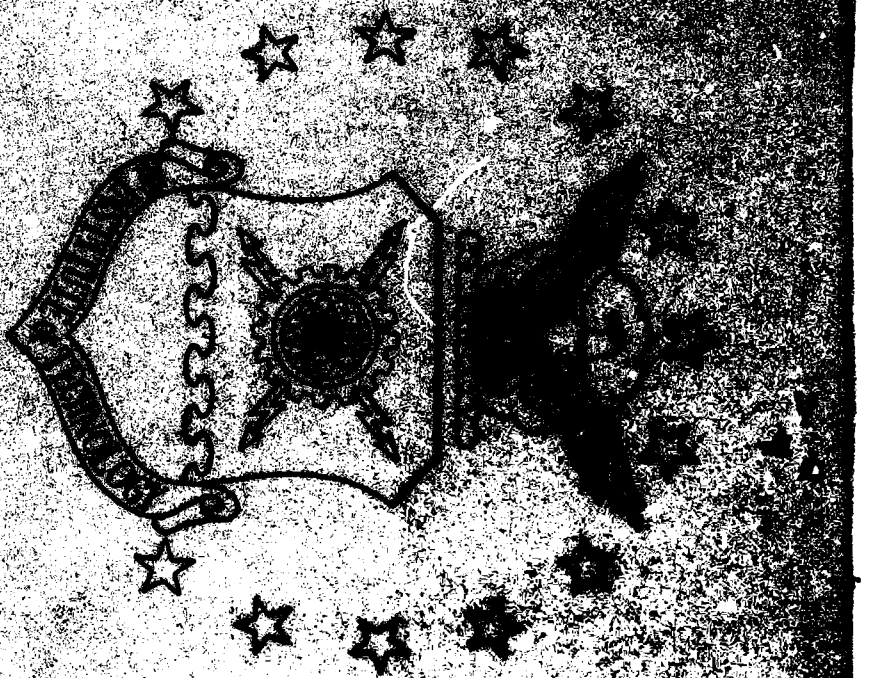

EXPERIMENTAL TESTING OF
FLYING QUALITIES THEORIES

Thesis

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EXPERIMENTAL TESTING OF FLYING QUALITIES THEORIES

THESIS

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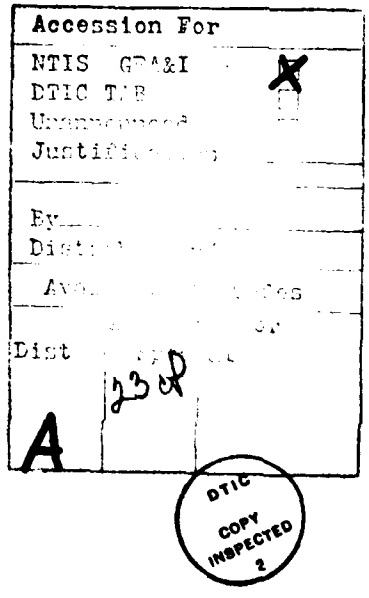

by

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Graduate Electrical Engineering

December 1982

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Preface

During my second quarter at the Air Force Institute of Technology, I was fortunate to hear Mr. Ron Anderson lecture on the problems with man-machine interface and how they affected flying qualities. When this thesis topic was proposed, I saw an opportunity to gain practical knowledge in an area encountered briefly before but never expanded on and thus chose this topic.

My thanks to Mr. R.O. Anderson who, as my thesis advisor and sponsor, gave me his valuable guidance and advice. My thanks to Mr. Tom Cord for his unending assistance and encouragement. I also thank Mr. Joe Marous and Mr. Mike Dammarell for their time and expertise in setting up the experimental simulator. In addition, thanks to Suzanne Weber for typing this thesis.

Finally, a special thank you for my wife and children. My wife, Leslie, who had the patience of Job and supported me during the trying times. My children, Caryn and Michael, both have shown an unusual amount of maturity and understanding during these difficult 18 months.

Nathan H. Krys

Contents

List of Figures

List of Tables

LIST OF SYMBOLS

$e^{-\tau s}$	time delay (sec)
F_{as}	stick force in roll axis (lb)
K	stick gain ((deg/sec^2)/lb)
P_{ss}	roll rate (deg/sec)
s	La Place operator
δ	stick deflection (in)
τ	time delay (sec)
Φ	bank angle (deg)
Φ_c	bank angle command (deg)
Φ_e	bank angle error (deg), $\Phi_e = \Phi_c - \Phi$
$\dot{\Phi}$	roll rate (deg/sec)
θ	pitch angle (deg)
ω_{sp}	short period natural frequency (rad/sec)
ξ_{sp}	short period damping, ratio

List of Abbreviations

deg	degrees
Eq	equation
fwd	forward
in	inches
lb	pounds
PR	pilot rating
pot	potentiometer
rad	radians
Ref	reference
RMS	root-mean-square
sec	seconds
TOT	time on target
vs	versus

Abstract

An analog computer simulation was used to model the roll dynamics of the generic aircraft which had been evaluated on the variable stability NT-33A aircraft. Sum of sine waves and random step functions were used as the two different command signals. The purpose of this study was to determine what effect the nature of the command signal had on the pilot rating of the task simulation.

The experiments consisted of fourteen different tests for each command signal. Five pilots, with varied flying experience, were instructed to follow the command signal in a pursuit flying task. The system time delay was varied from 0.1 to 0.8 seconds. The highest frequency component of the input signal was 2.54 radians/second. The subjects used a control stick while looking at an oscilloscope displaying the command signal and the subjects's response. RMS error, time on target, and the Cooper-Harper rating scale were used as performance measures.

The experiments showed that the subjects considered the sum of sine waves task closer to an actual flying task. In addition, as the time delay was decreased, the subjects preferred K/s-like dynamics.

EXPERIMENTAL TESTING OF FLYING QUALITIES THEORIES

I. Introduction

Background

The increasingly complex control systems of modern fighter aircraft have resulted in closed-loop system dynamics substantially different from traditional flight dynamics. Because of these differences, it is nearly impossible to accurately predict pilot-aircraft performance and pilot rating for many of the aircraft/control systems now being tested or designed. The small data base on handling qualities of modern aircraft (or high-order systems) compounds the difficulty. Traditional aircraft flight dynamic characteristics for favorable pilot ratings on different levels of flying quality are contained in the old Military Specification, MIL-F-8785B. However, because the modern system dynamics which increase the aircraft capabilities and add to its complexity, the criteria in that Military Specification are not adequate to evaluate or predict the the flying qualities of modern aircraft/control systems (Ref 2). This situation provided the motivation for the simulations reported in this thesis, as well as the revision to the Specification, MIL-F-8785C (Ref 1).

Current aircraft modeling concepts can shed some

light on predicting the flight qualities of new aircraft by man-in-the-loop simulations. One can place a pilot in a system simulation programmed with the proper aircraft equations of motion and control systems dynamics where the pilot-aircraft performance can be observed.

Two, of many, previous studies were done for the Air Force Wright Aeronautical Laboratories/Flight Dynamics Laboratory (AFWAL/FDL) by the Calspan Advanced Technology Center using the USAF/Calspan variable stability NT-33A aircraft. The NT-33A is a test bed used to study the effects of different control system dynamics (Refs 2; 3).

Up until the recent NT-33A studies (Refs 3; 5), the prevailing theory was that K/s-like dynamics are the ideal transfer function. Earlier studies with the NT-33A suggested similar conclusions. However, very little data were available to reach a definite conclusion. The origin of using ideal dynamics represented by the simple transfer function K/s was obtained during ground-based compensatory tracking tasks using a sum of sine waves signal for the input. A compensatory tracking task is one where the subject sees only the system error and tries to correct this error. The recent NT-33A experiments, however, used a pursuit task in an airborne flight with step inputs. A pursuit task shows both command signal and aircraft position, the difference between the two is the error. The purpose of this thesis is to use a ground-based experiment to evaluate the differences in experimental conditions.

The Air Force Wright Aeronautical Laboratories, (AFWAL) Wright-Patterson AFB, is interested in this research for possible application to future specifications.

Problem

AFWAL desires the simulation of the dynamics used in the NT-33A duplicated in the laboratory and a comparison of these ground results with the actual flight data. The specific tasks required are:

1. Determine the effect that the type of tracking command (random vs. step) has on the pilot rating during a roll tracking task with various roll time constants.
2. Determine the effect of stick sensitivity (gain) on pilot rating for these same cases.
3. Develop a data base of simplified low order equivalent system results that can be used to predict the handling qualities for high order models in the pitch axis.

Scope

The experiment is concerned only with studying the flying qualities of the dynamics used in the NT-33A aircraft as simulated on the Electronic Associates Incorporated (EAI) 2000 Analog Computer. The roll task has two different inputs. The first test examines the roll task with a sum of sine waves input. The other test uses a random square wave

input. The pitch task uses only the sum of sine waves as an input.

Three performance measures are used. The Cooper-Harper Pilot Opinion Rating Scale (Fig 1) is be the subjective performance measure, while RMS error and time on target are the objective performance measures. A performance measurement is an evaluation of how well a system operates (i.e., how well the output follows the input or how small the error can be maintained over a given period of time).

Assumptions

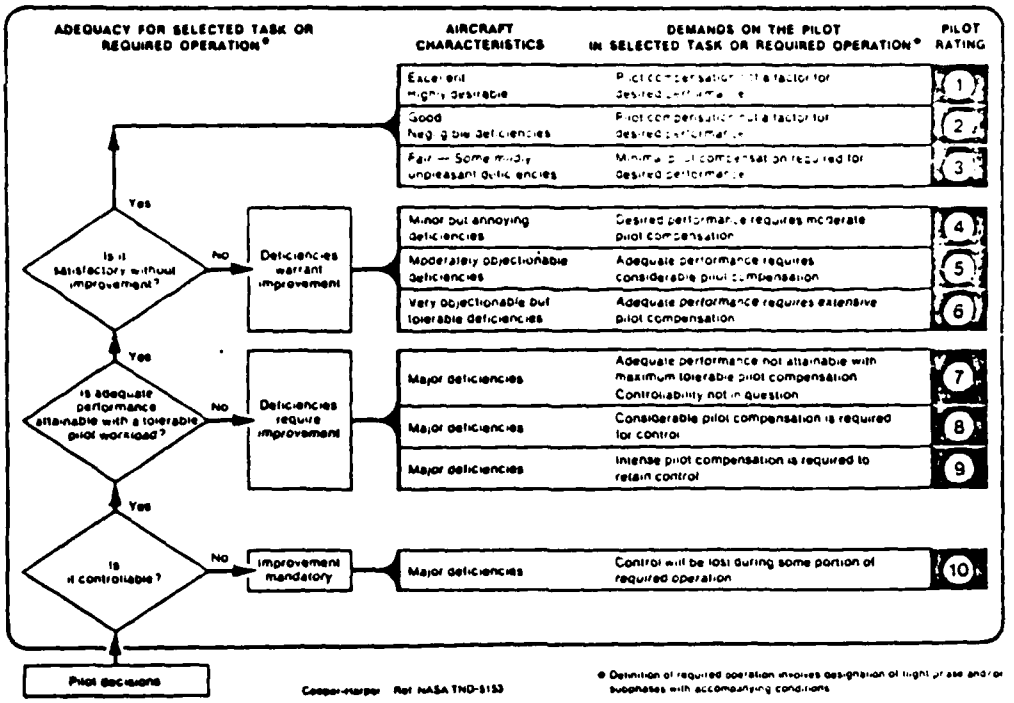
1. The Aeronautical Systems Division (ASD) EAI 2000 Analog computer will be a good representation of the dynamics simulated with the NT-33A.

2. The volunteer pilots will be a good representation of USAF "line" pilots.

Approach

The pitch (Ref 7) and roll (Refs 3; 5) equations were provided by AFWAL. Chapter II discusses the experimental approach and how the equations were implemented on the EAI 2000 Analog computer. Chapter III presents the results, problems encountered during the simulation, and observations. Chapter IV presents conclusions and further recommendations resulting from this study. The appendices contain additional pertinent information and tabulated results.

HANDLING QUALITIES RATING SCALE



DEFINITIONS FROM TN-D-5153

COMPENSATION

The measure of additional pilot effort and attention required to maintain a given level of performance in the face of deficient vehicle characteristics.

HANDLING QUALITIES

Those qualities or characteristics of an aircraft that govern the ease and precision with which a pilot is able to perform the tasks required in support of an aircraft role.

MISSION

The composite of pilot-vehicle functions that must be performed to fulfill operational requirements. May be specified for a role, complete flight, flight phase, or flight subphase.

PERFORMANCE

The precision of control with respect to aircraft movement that a pilot is able to achieve in performing a task. (Pilot-vehicle performance is a measure of handling performance. Pilot performance is a measure of the manner or efficiency with which a pilot moves the principal controls in performing a task.)

ROLE

The function or purpose that defines the primary use of an aircraft

TASK

The actual work assigned a pilot to be performed in completion of or as representative of a designated flight segment.

WORKLOAD

The integrated physical and mental effort required to perform a specified piloting task.

Fig 1. Cooper-Harper Pilot Rating Scale (Ref 3)

II. Experimental Approach

General

This thesis documents the experimental study of the dynamics of the roll and pitch axes of conventional aircraft (Fig 2). The roll task will have two alternate inputs, a sum of sine waves and a random step function. The pitch task will deal only with the sum of sine waves input. All experiments took place in Building 676, the Aeronautical Systems Division (ASD) computer center. The roll and pitch equations were simulated on the EAI 2000 analog computer. A control stick obtained from bench stock was used (Fig 3). The stick was free to move in both the pitch and roll axes. More detailed information on the stick is found in Appendix A. The stick was used by the pilot to follow the command signal in a pursuit environment. Only one axis of the stick was used per task. The command and stick signals were displayed on a dual trace Tektronics oscilloscope, type 454 (Fig 4). The flying W represents the pilot's simulated aircraft. The pilots were instructed to maintain minimum error between the command signal and the flying W (Fig 5).

Experimental Setup

The simulation was performed on the EAI 2000 analog computer. Figure 6 shows a simplified block diagram of the system. The analog circuitry of the system (see Appendix B)

was installed on the EAI 2000 in the normal fashion with output displayed on the oscilloscope. The pilot was instructed to minimize error by moving the control stick in the proper direction. All runs were timed for 90 seconds. The RMS error and time on target were monitored and kept on MODCOMP Classic IV hook-up.

Simulator

Figure 7 shows the simulator setup for this experiment. It consists of a flat chair (no wheels), the stick, and a dual trace oscilloscope. The stick polarity was set similar to an aircraft stick. Force applied away from the subject caused the W to move down and vice versa. Since the simulation was flown one axis at a time, it would not be possible to perform roll and pitch motion at the same time. For each task the pilot was given several practice runs until he felt comfortable with the task and apparatus. Distance between pilot and scope varied with the pilot concerned. On the average, the distance was two feet from the head of the pilot to the oscilloscope. All the pilots used the stick as a center stick.

Aircraft Equations

The roll equation used is the same used by Monagan (Ref 3). The pitch equation came from NASA contractor report CR-2144 (Ref 7). The equations are shown below.

Roll equation:

$$\frac{\Phi}{F_{AS}} = \frac{K}{s(s + 1/\tau_R)} \qquad (1)$$

Pitch equation:

$$\frac{\theta}{F_{AS}} = \frac{K}{s}\left[\frac{s + \frac{1}{\tau}}{\frac{s^2}{\omega_{sp}^2} + 2\frac{\xi_{sp}}{\omega_{sp}} s + 1}\right] e^{-\tau s} \qquad (2)$$

Pade's approximation for $e^{-\tau s}$ was used in the pitch simulation. All analog circuit drawings appear in Appendix B.

Pade's approximation:

$$e^{-\tau s} = \frac{2 - \tau s}{2 + \tau s} \qquad (3)$$

Command Signals

The sum of sine waves command signal is similar to the one used in AFFDL-TR-65-15. This experiment uses six different sine waves because of equipment limitations. The frequency components for the sine wave are shown in Table 1. Each sine wave had a peak voltage of one volt to ensure the command signal would not go off the face of the scope (6 volts). This signal was used for roll and pitch.

The random step function used the sum of sine wave signal as both a trigger to start the random appearing step and set the value for the step voltage. A more detailed explanation of both circuits appears in Appendix B.

TABLE 1
Sum of Sine Waves
(Ref 4)

ω_n
0.262 rad/sec
0.393
0.602
0.969
1.49
2.54

Presentation of Task

During a tracking task the pilot is aware of two parameters, his position and the target's position. A difference between the two positions is an error. The pilot task is to minimize the error. In this simulation, the command signal is a horizontal line on the scope. The command signal in the pitch axis moves up or down and will not go off the face of the scope. For the roll task, the command signal rotated 34 degrees left or right on the scope because of equipment limitations. A typical presentation of both tasks is shown in Fig 4. To correct the pitch error displayed, the pilot must pull back or push forward on the stick, causing the W to rise or fall and follow the command signal. To correct the roll error, the pilot must push the stick toward the left or right, which will make the W rotate in the direction of the command signal.

During the first roll tests, pilots were confused as to which signal was which when the W and command signals were superimposed. To eliminate this confusion, the signals

were separated by two divisions on the scope face. This confusion did not occur in the pitch task.

A normal run began with the command and W lines horizontal on the scope face, with no initial conditions. The pilots were instructed to keep the error at zero for 90 percent of the time for as long as possible. When the pilot was ready, the computer operator started the command signal. Then the pilot began tracking his target. The data variables monitored were command signal, stick output (δ), error, pitch or roll rate, RMS error and time on target. RMS error and time on target were read on a digital printout, while the other signals were on a strip chart. Each run was 90 seconds long. Figure 7 shows a typical strip chart recording for the experiment.

The Gathering of Data

Once the position of the stick and scope were adjusted for the comfort of the pilot, a training period began. A training period consisted of as many runs as the pilot wished, usually three to five runs. This allowed for further adjustment of the stick, scope and chair, as well as familiarity with the task involved. The testing began when the pilot was ready.

The roll task consisted of fourteen runs. These runs were made up of four sets of three runs and one set of two runs. During each set of runs, τ_R would remain the same and stick gain would vary. For the last run of each set, the

subject was asked if the task could be improved. If so, which run was preferred. Should the stick act more like task A, task B, or someplace in between? The subject would then fly a 45-second test run. This allowed him to judge if the stick characteristics were improved. This testing procedure continued until optimum performance of the system was reached. Then the subject would fly the new system for a recorded 90 seconds.

At no time did the subject know what parameter had changed. He only knew the stick would handle differently, and his preference was used to improve the system. After completing each run, the subject was asked for comments and a Cooper-Harper rating for the task. He was reminded not to rate himself, but the task.

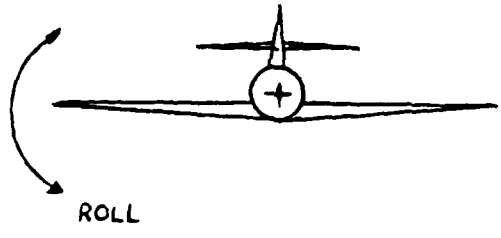
To present the tasks in a random fashion, all subjects were started on a different set of tasks. For instance, SF began the roll task with sum of sine waves test one and ended with test fourteen. DS started with sum of sine waves test four and ended with test three. This allowed for a randomized test. Table 2 lists the parameters tested (Ref 3). However, these parameters were not actually tested due to an error. The details are discussed in Chapter III.

The pitch task was cancelled due to problems with the simulation. The details are also discussed in Chapter III.

TABLE 2

Parameters and Values
(Ref 3)

Variable	Tested Parameter
τ_R	.1, .15, .25, .45, .8 sec
$\frac{P_{SS}}{F_{AS}}$	10, 25 Set by Pilot (deg/sec)/lb



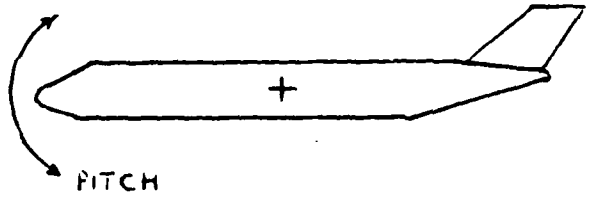


Fig 2. Pitch and Roll Axes

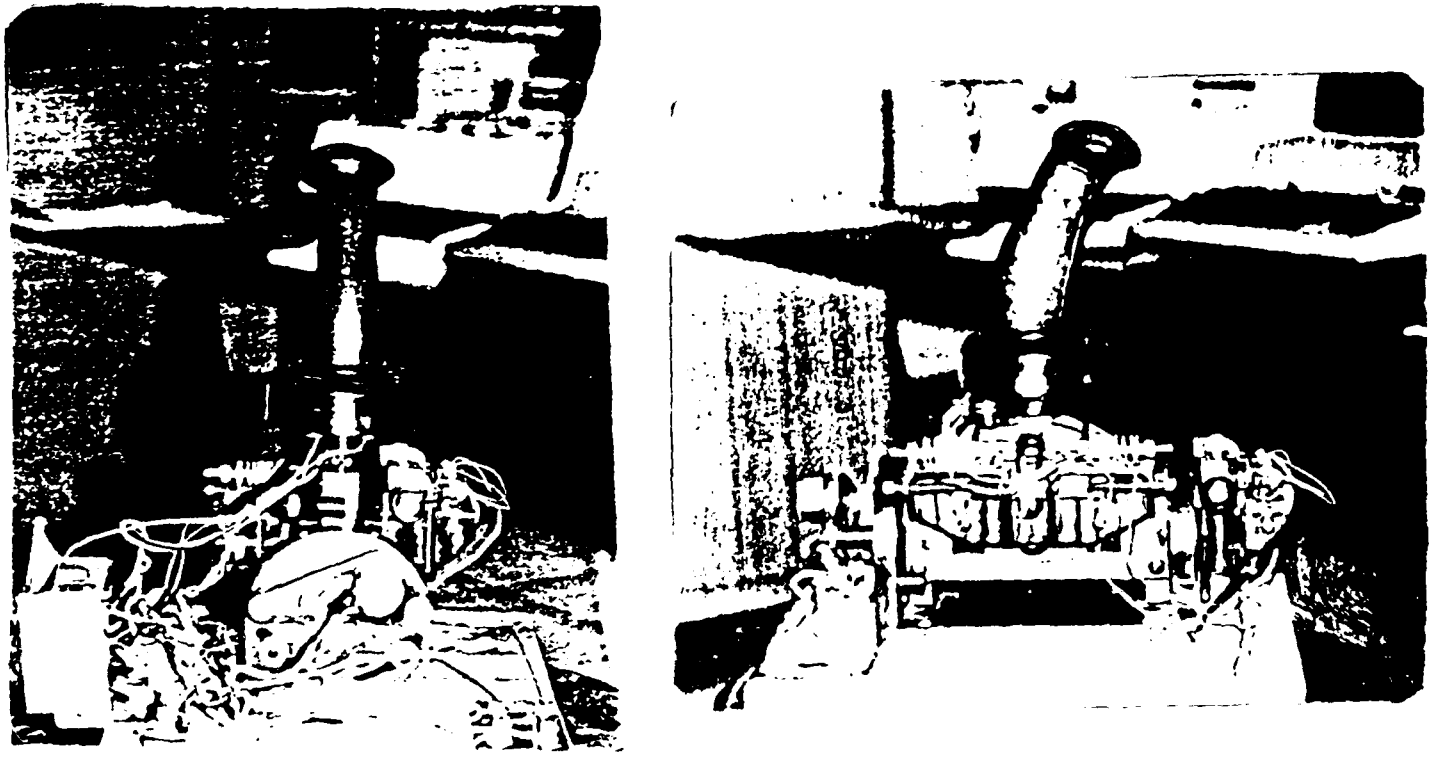


Fig 3. Front and Side of Stick

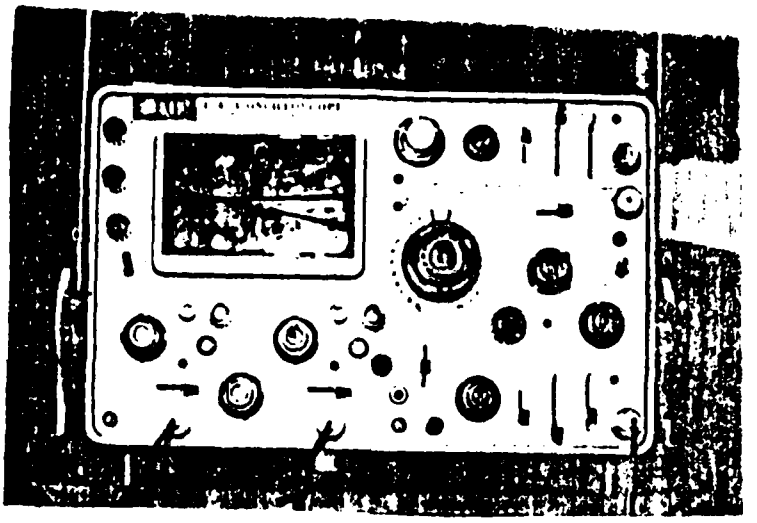


Fig 4. Oscilloscope Display

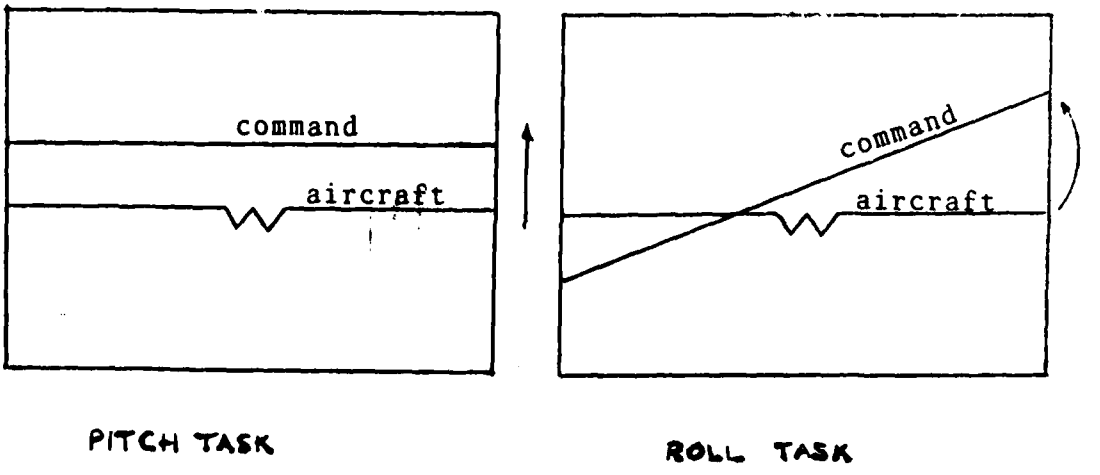


Fig 5. Task Displays

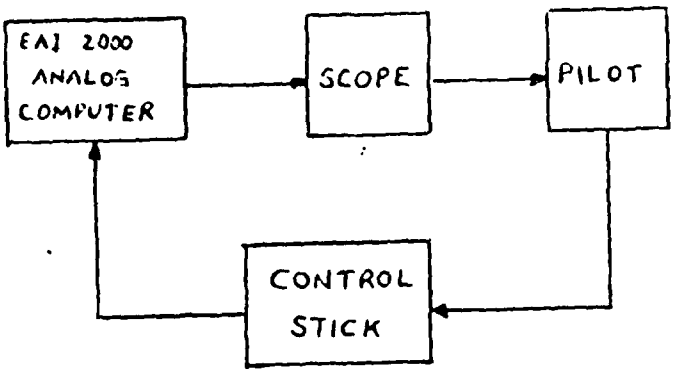


Fig 6. System Block Diagram

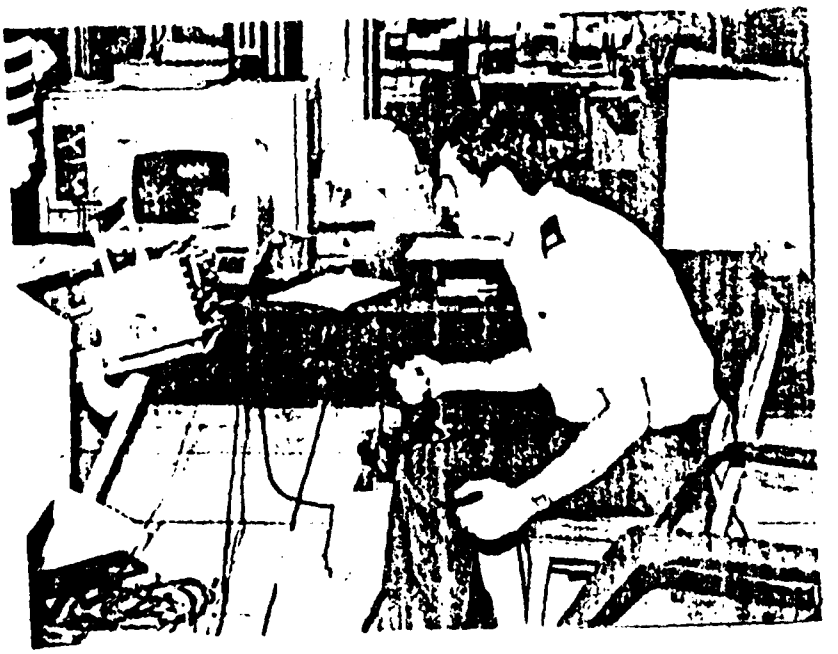


Fig 7. Simulator

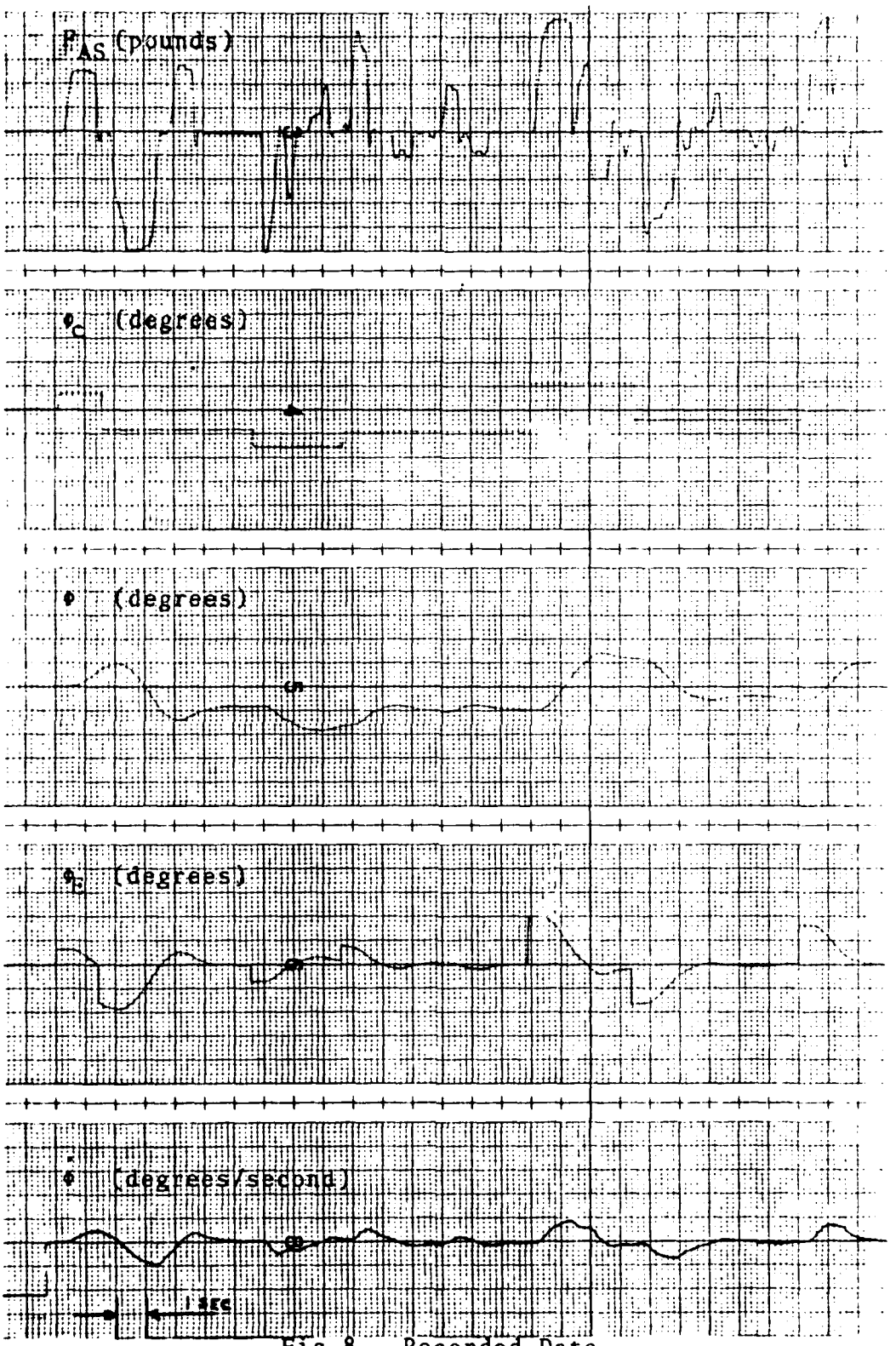


Fig 8. Recorded Data

III. Experimental Results

This chapter contains the data from all the experimental runs with the five subjects. The problems, observations and results are also presented and discussed.

Pitch Task

The pitch task was never accomplished due to a stick "bobble" which appeared in the scope display during the initial tests. A bobble is a continued movement of the subject response (W) when no force is applied. The subjects noticed that the W on the scope would make a slight downward movement after the desired response was complete. This problem was later traced to the simulated pitch equation. The connections to the control stick were interchanged to allow the pitch axis to be connected to the roll equation and vice versa. After the connections were made, the pitch display had no bobble but the roll did. This procedure eliminated the control stick as the problem, leaving the simulation equation as the source of the bobble.

As a result, the roll tests were continued while attempting to solve the problem with the pitch equation. This problem was very disturbing since the equation is an actual description for the T-33 pitch dynamics. The problem was never rectified, and we still do not know why the bobble is present. To continue the research, other equations recom-

mended by AFWAL were simulated. The second equation is shown below:

$$\frac{\theta}{\delta} = \frac{K(s + \frac{1}{\tau})}{s(\frac{s^2}{\omega^2} + 2\frac{\xi}{\omega}s + 1)} \qquad (4)$$

Although this equation is very similar to the original equation, this simulation was not stable. Recently another much simpler equation was simulated on the EAI 2000, and no bobble or instability problems occurred. The simpler equation is shown below:

$$\frac{\Phi}{\delta} = \frac{Ke^{-\tau s}}{s(s + \frac{1}{\tau_R})} \qquad (5)$$

Due to the coordination needed for ASD employees to be present during test runs, conflicts with subject pilots' schedules and the small amount of time left for further research, this last equation was not pursued any further. It was decided to document what had happened and recommend that the last equation be used for further research. The schematic diagram for Eq (5) is found in Appendix F.

If the pitch equation had no problems, the data would have been used to start a data base for low-order equivalent system results to aid in predicting the handling qualities of high-order systems.

Roll Task

Table 2 (Chapter II) shows the original values for the proposed test parameters. These parameters were not tested due to a factor not accounted for in the roll simulation. Therefore the values shown in Table 3 were tested. To switch from one test to another in the simulation, one potentiometer was used to set the value for K. Typing in the value for time delay on the CRT set the value for τ_R. After the results were examined in detail, it was discovered the K potentiometer included a τ_R factor which was not accounted for. This unaccounted factor changed all the values for K and P_{SS}/F_{AS} values. Table 3 shows the actual parameters tested.

TABLE 3

Actual Tested Values

τ sec	K $\frac{deg/sec^2}{lb}$	P_{SS}/F_{AS} $\frac{deg/sec}{lb}$
0.1	1000.00	166.66
0.15	1111.11	66.66
0.15	444.44	66.66
0.25	400.00	100.00
0.25	160.00	40.00
0.45	49.38	22.22
0.45	123.42	55.54
0.8	15.63	12.50
0.8	39.10	31.28

Note: K optimum was set by the subject (see Tables 4 and 5)

A summary of the results in tabulated form is found in Tables 4 and 5. The tables show the 14 different tasks, pilot ratings, time on target (TOT), RMS error, and the

TABLE 4

Random Step Summary

	Subjects														
	SF			MM			DS			RL			MK		
PR	TOT	RMS	PR	TOT	RMS	PR	TOT	RMS	PR	TOT	RMS	PR	TOT	RMS	
Test 1 τ=.45 K=49.38															
6	70.57	18.5	6	73.98	13.4	7	78.56	13.4	3	74.51	19.4	4	83.4	12.5	
Test 2 τ=.45 K=123.42															
8	75.21	16.8	4	80.86	14.1	3	79.70	14.9	2	80.18	14.2	4.5	79.50	14.3	
Test 3 τ=.45															
	K_{opt}=88.88			K_{opt}=155.55			K=123.42			K_{opt}=444.44			K_{opt}=4444		
7	77.43	19.4	2.5	77.68	16.8		NO IMPROVEMENT			80.12	14.2	4	78.77	14.9	
Test 4 τ=.25 K=400															
7	77.43	16.7	4	73.40	16.6	2	83.1	15.0	3	76.87	16.1	3	82.0	11.9	
Test 5 τ=.25 K=160															
2.5	80.15	15.2	2	73.42	18.4	3	78.9	14.9	2	76.43	17.5	3	82.77	12.1	
Test 6 τ=.25															
	K_{opt}=140			K_{opt}=240			K_{opt}=360			K_{opt}=208			K_{opt}=500		
2	79.50	15.6	1.5	73.96	14.7	2	82.23	13.6	2	81.07	15.9	3	80.7	11.8	
Test 7 τ=.8 K=15.63															
7	70.56	18.5	5.5	66.16	16.8	7.5	66.20	22.9	4	69.23	18.1	4	72.1	17.4	

NOTE: K_{opt} equal to pilot optimum gain

TABLE 4, continued

	Subjects														
	SF			MM			DS			RL			MK		
PR	TOT	RMS	PR	TOT	RMS	PR	TOT	RMS	PR	TOT	RMS	PR	TOT	RMS	
Test 8 τ=.8 K=39.1															
8.5	70.52	19.0	5	63.02	21.6	7	77.43	17.3	4	74.22	16.8		74.4	18.2	
Test 9 τ=.8															
	K_{opt}=62.5			K_{opt}=100			K_{opt}=125			K_{opt}=100			K=15.63		
5	76.72	16.0	4	75.97	14.5	5.5	81.15	15.4	4	77.00	15.0	NO IMPROVEMENT			
Test 10 τ=.15 K=1111.1															
2.5	80.06	14.2	7	76.42	14.0	5.5	77.56	18.0	3	81.52	14.3	3	80.05	14.6	
Test 11 τ=.15 K=444.44															
5	82.6	13.2	2.5	70.38	17.1	2	82.76	14.0	3	83.32	15.4	3	83.0	13.8	
Test 12 τ=.15															
	K_{opt}=833.33			K_{opt}=533.33			K_{opt}=533.33			K_{opt}500			K_{opt}=1333.33		
2	82.52	12.7	1	77.71	16.8	1	82.77	14.3	3	83.56	12.8	3	80.72	14.4	
Test 13 τ=.10 K=1000															
2	84.45	12.8	5	74.22	15.6	2	82.20	14.9	3	83.74	13.1	3	83.20	11.7	
Test 14 τ=.10															
	K_{opt}=750			K_{opt}=850			K_{opt}=600			K_{opt}=750			K_{op}=750		
3	84.24	11.8	1	78.60	13.9	1.5	82.85	13.1	2	83.40	13.1	2.5	85.31	11.7	

NOTE: K_{opt} equal to pilot optimum gain

TABLE 5
Sum of Sine Waves Summary

	Subjects														
	SF			MM			DS			RL			MK		
PR	TOT	RMS	PR	TOT	RMS	PR	TOT	RMS	PR	TOT	RMS	PR	TOT	RMS	
Test 1 τ=.45 K=49.38															
5	41.97	18.3	6	68.42	12.4	4	73.16	10.9	6	60.13	13.5	6	52.82	15.0	
Test 2 τ=.45 K=123.42															
3	49.58	15.3	4	80.07	10.7	3	82.17	10.5	5	72.88	11.5	4.5	60.94	13.7	
Test 3 τ=.45															
	K_{opt}=166.66			K_{opt}=277.77			K_{opt}=333.33			K_{opt}=277.77			K_{opt}388.88		
2	54.82	13.9	2	87.37	10.1	2.5	84.84	10.9	4	66.81	11.6	5	67.88	11.4	
Test 4 τ=.25 K=400															
1.5	65.81	11.5	4	87.31	9.9	2	84.67	9.6	4	69.73	11.7	3	73.90	11.1	
Test 5 τ=.25 K=160															
7	44.17	20.3	5.5	86.92	10.3	2.5	79.92	10.2	4	70.65	11.2	4.	72.42	12.3	
Test 6 τ=.25															
	K_{opt}=320			K_{opt}=600			K_{opt}=320			K_{opt}=600			K_{opt}=800		
2	56.59	15.7	1.5	88.79	10.0	2	83.76	9.8	3	77.00	10.9	3	84.71	11.2	
Test 7 τ=.8 K=15.63															
8	29.40	27.1	8	75.25	11.7	7.5	50.16	17.2	7	53.94	16.1	7.5	39.25	19.8	

NOTE: K_{opt} equal to pilot optimum gain

TABLE 5, continued

	Subjects														
	SF			MM			DS			RL			MK		
PR	TOT	RMS	PR	TOT	RMS	PR	TOT	RMS	PR	TOT	RMS	PR	TOT	RMS	
Test 8 τ=.8 K=39.1															
7	32.95	23.4	5.5	83.82	10.6	7	50.34	15.0	7	55.72	14.5	7	43.93	18.3	
Test 9 τ=.8															
	K_{opt}=237.5			K_{opt}=143.75			K_{opt}=225			K_{opt}=156.25			K_{opt}=225		
4	50.32	16.9	3	87.44	10.0	4	74.92	10.7	6	58.32	13.8	4.5	54.41	13.9	
Test 10 τ=.15 K=1111.1															
1	66.56	15.4	4	79.43	12.0	4	85.41	9.6	5	72.57	11.8	3	67.50	9.6	
Test 11 τ=.15 K=444.44															
4	62.38	13.9	2.5	85.65	10.4	3	83.80	9.8	6	70.30	12.0	3	70.83	11.3	
Test 12 τ=.15															
	K_{opt}=666.66			K_{opt}=833.33			K_{opt}=833.33			K_{opt}=833.33			K_{opt}=900		
1	72.65	13.0	2	85.97	10.2	2	87.36	9.5	3	83.10	10.3	2	73.23	11.2	
Test 13 τ=.10 K=1000															
3	70.01	14.5	4	91.10	9.8	1.5	88.95	9.4	4	77.17	10.9	2.5	86.95	10.3	
Test 14 τ=.10															
	K_{opt}=750			K_{opt}=1250			K=1000			K_{opt}=1500			K_{opt}=2000		
3	74.41	11.0	1	91.32	9.6	NO IMPROVEMENT			2	82.10	10.5	2.5	87.51	10.0	

NOTE: K_{opt} equal to pilot optimum gain

optimum gain (K) values for the two different inputs. Please note, P_{SS}/F_{AS} values above 75 are not attainable with real aircraft. Since the error was not discovered until after the data were taken, all the data and parameters are displayed to establish trends within the data.

All the pilots agreed that the sum of sine waves task appeared to act more like an airplane flying task when compared to the step function input. Several pilots commented that the step function input task was superficial and did not "act like an airplane." Furthermore, the random step task was easy, and they knew more than enough time was available to minimize the error between signals. More information regarding pilot experience is found in Appendix D. Pilot comment data is found in Appendix E.

Time on Target

Figures 9 through 16 show the pilot rating versus time on target data for the two different inputs. The random step data do not show any apparent consistent trends. It is suspected the subjects were not sensitive to this measure except where the time delay was high ($\tau = 0.8$). The sum of sine waves data, on the other hand, show definite trends. All the tests (except $\tau = 0.1$) show that all the pilots gave low ratings for high time on target results. The subjects were better able to evaluate the dynamics for the sum of sine waves task and were certainly more consistent with each other. The high ratings (poor performance) reflected direct-

ly the degree of pilot compensation and workload needed to minimize the error for each task. In comparison, the sum of sine waves data shows more sensitivity and the subjects were better able to judge their task, since high time on target tasks received low ratings. Probably the degree of pilot compensation and workload account for the higher ratings for the square wave task. In addition, there was more consistency in pilot ratings between the sum of sine waves task as compared to the step function.

RMS Error

Figures 17 through 21 show the pilot rating versus RMS error for the two different inputs. Again, the data show inconsistencies for the random step data and definite trends for the sum of sine waves data. The subjects appear to be more sensitive to RMS error data due to the data lines not being as steep as the time on target data.

The high pilot ratings for high RMS error and vice versa seem reasonable. The data for the random step show the subjects were more sensitive to this measure, but they were not consistent (except where $\tau = 0.8$). In comparison, the sum of sine waves data show a definite agreement among the ratings and lower ratings were given for lower RMS error. Again, the high ratings are a measure of how much pilot compensation is necessary to manage the workload.

Time Delay (τ)

Figure 22 is a composite for all the time delays

versus pilot ratings for those values of K that were chosen by the subjects. At the top of the graphs are the average optimized stick gains. As can be readily seen, there is very little difference between the two different inputs. However, it is interesting to note that the subjects preferred higher gains for lower time delays and higher gains were preferred for the sum of sine waves task when compared to the step function. This figure clearly shows K/s-like dynamics were preferred for both inputs.

Stick Gain (K)

Figures 23 through 29 show stick gain versus pilot rating. The higher the gain, the more sensitive the stick reacts to stick input. For the step input, the inconsistencies continue and no trends are shown. For the sum of sine waves, however, a definite trend is shown. First, the subjects were most sensitive to stick gain. In addition, the subjects were very consistent. The subjects generally gave the higher gains lower pilot ratings. When τ was equal to 0.15 (very responsive aircraft), an optimum gain was obtained between 600 and 900. This illustrates that after a certain point high pilot ratings were given, the gain reached a point where the simulation was just too responsive. This is why no straight trends lines appear in Fig 28. (Since this was a trend in itself, this author connected the points with straight lines to emphasize the agreements between all of the subjects for stick gain where $\tau = 0.15$.)

To correlate the runs, mean RMS error and time on target were graphed in Figs 30 and 31. It was expected that a simulation resulting in a low RMS error and high time on target would reflect "good" flying qualities and "low" pilot ratings. For the random step this was not the case (Fig 30). In fact, this result agrees with Monagan (Ref 3). There was no apparent correspondence between time on target, RMS error and pilot rating. For the sum of sine waves, on the other hand, Fig 31 shows a definite correlation between the three different levels of flight characteristics. This figure definitely shows "poor" flying qualities tend to be associated with higher RMS errors and with low time on target. Arcs are shown between what might be considered the three different levels of flying qualities. This agrees with Onstott (Ref 12). Onstott concluded that a pilot will tolerate more sluggish response in a given flying level if the resulting time on target is good.

Figures 32 and 33 compare stick gain versus time delay with the flying quality level shown. All that can be deduced from these figures is that the subjects preferred low time delays with high gains. However, the data points to the extreme right should not be considered valid since these gains cannot be attained with real conventional aircraft. These points are displayed only to show trends. Note, as τ decreased, the subjects preferred higher stick gains and the rating improved, indicating a preference for "K/s-like" systems. This data is in direct conflict with Chalk and

Monagan. However, the difference could be due to motion effects present in the NT-33 experiment and not here. Add this conflict to the extremely consistent data with the sum of sine waves command signal tests and a question arises. Namely, are random step function command signals useful in defining flight characteristics alone or should a variety of different command signals be used? The data seem to speak for themselves.

In summary, the experimental results show the subjects preferred K/s-like aircraft characteristics. Figure 21 clearly illustrates that as τ decreased, pilot ratings improved for the two different inputs. In addition, the above results certainly lead one to question why the step signals were used. It might also be recommended that step functions not be used as the only inputs to define flying characteristics.

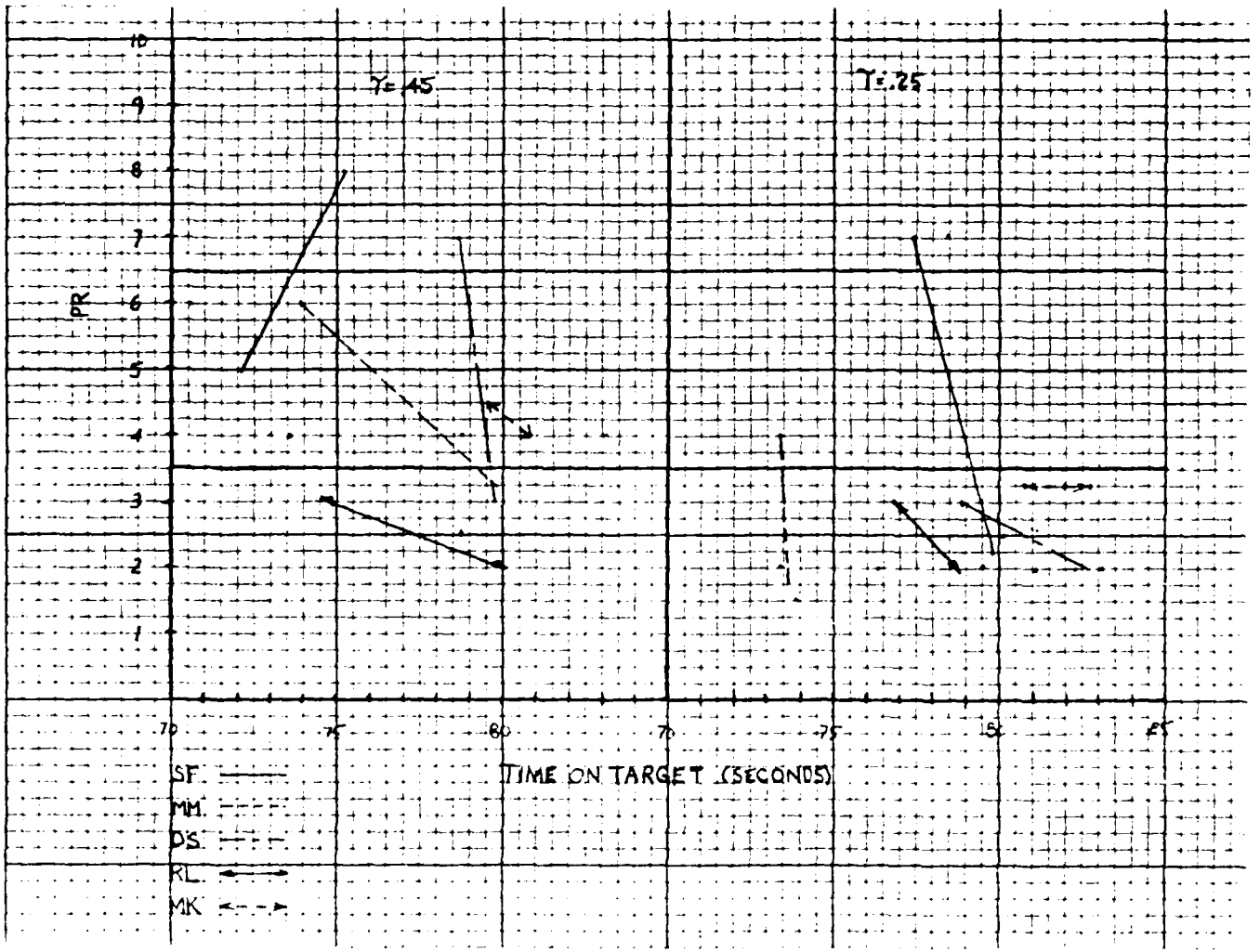


Fig 9. PR vs Time on Target (Random Step)

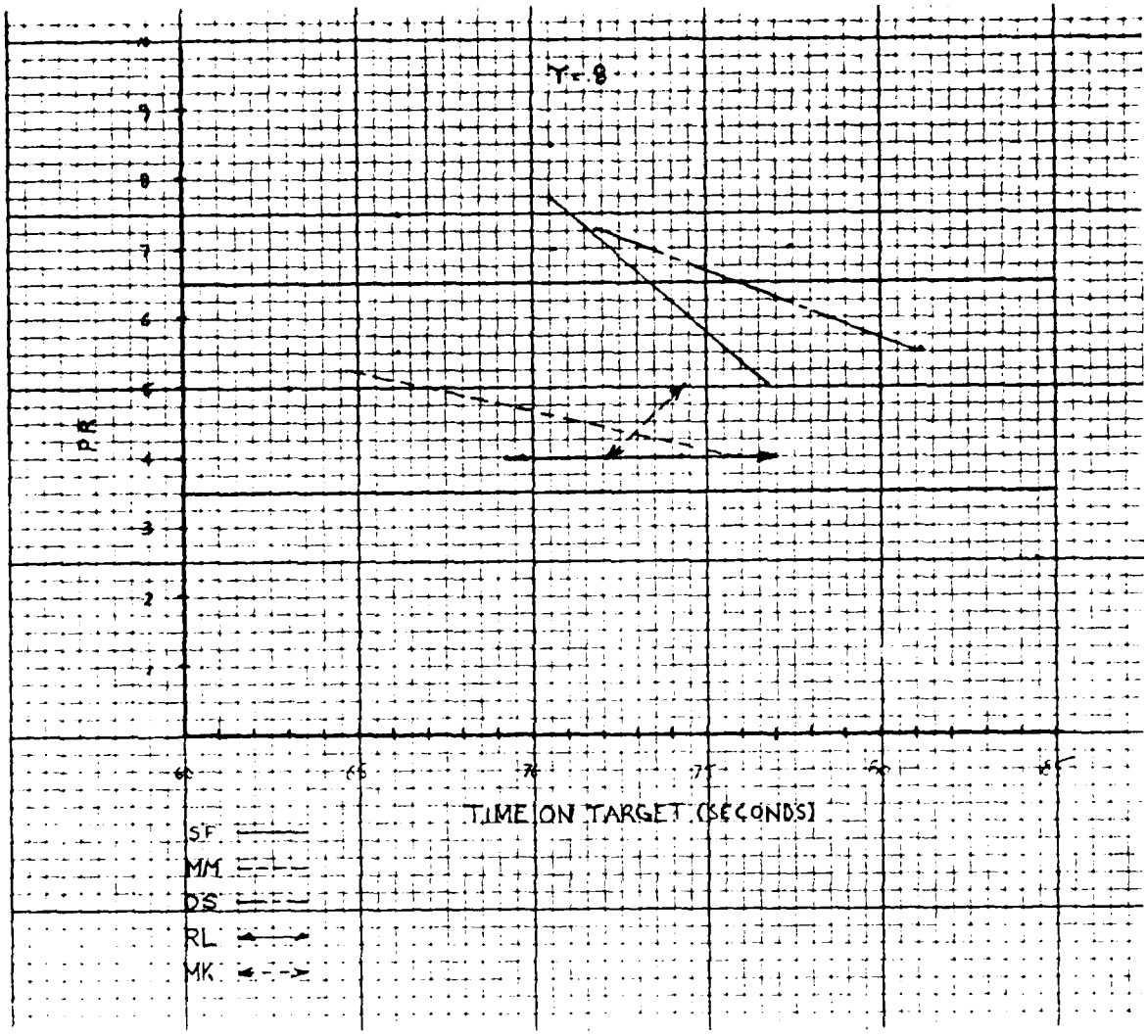


Fig 10. PR vs Time on Target (Random Step)

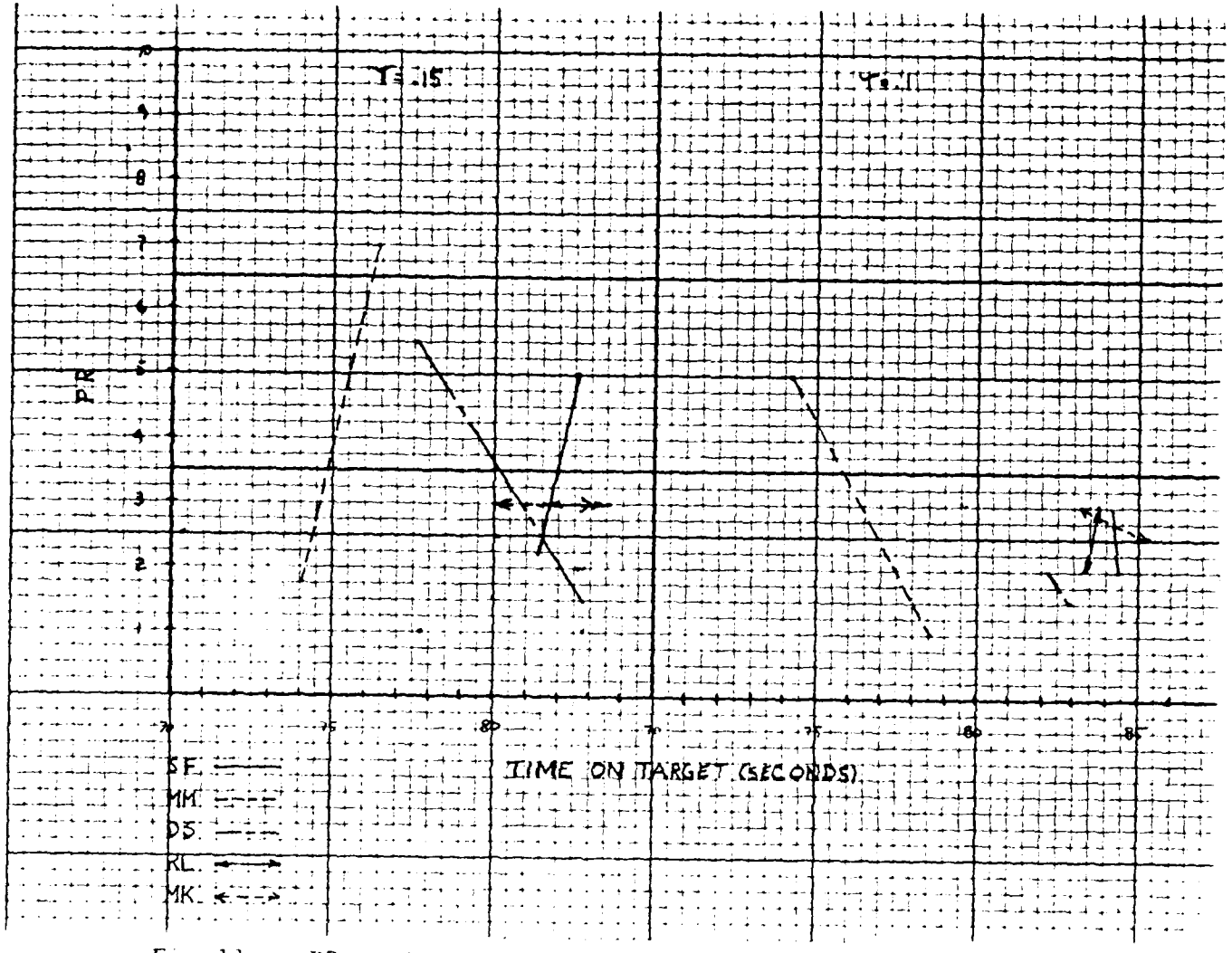


Fig 11. PR vs Time on Target (Random Step)

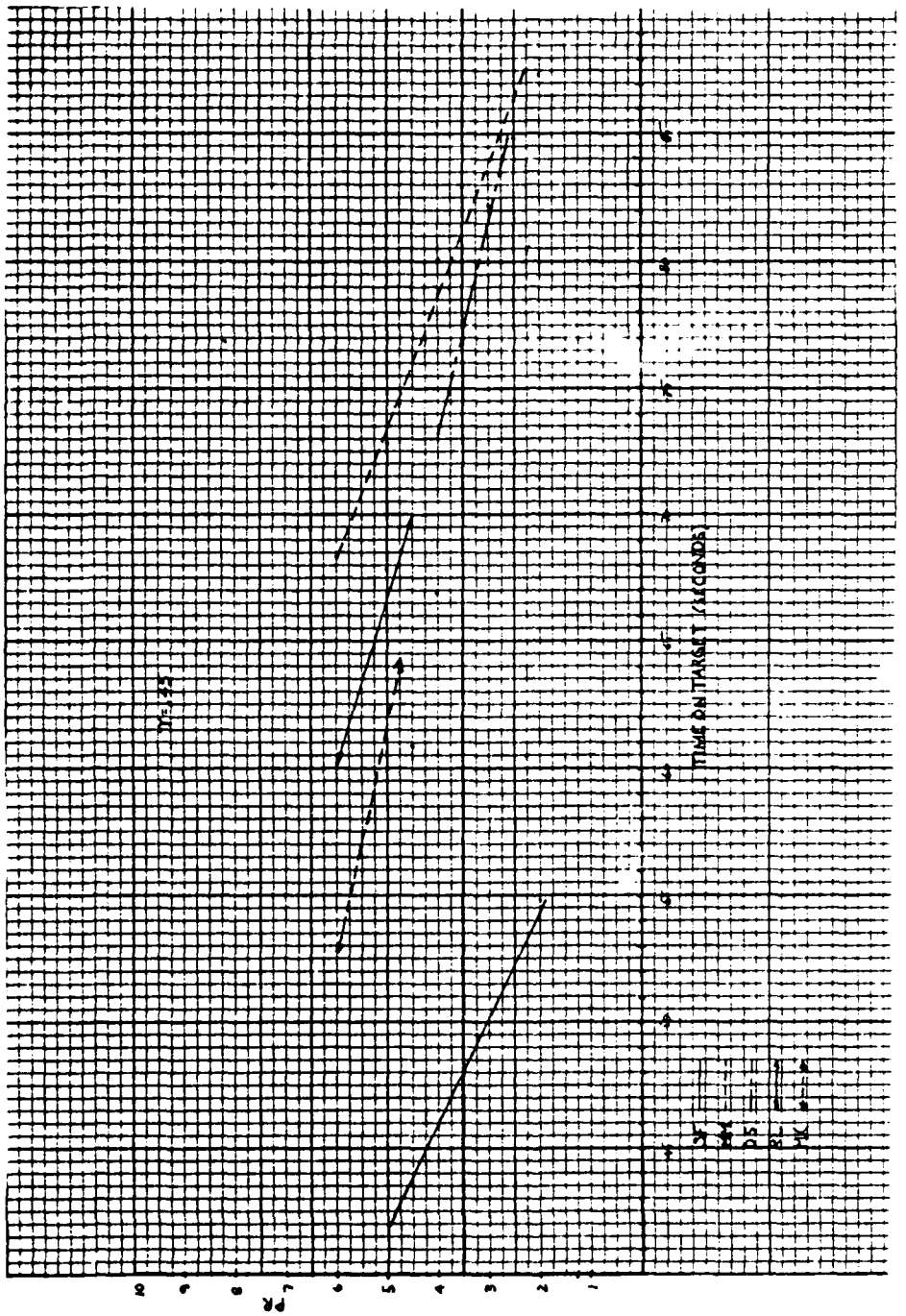


Fig 12. PR vs Time on Target (Sum of Sine Waves)

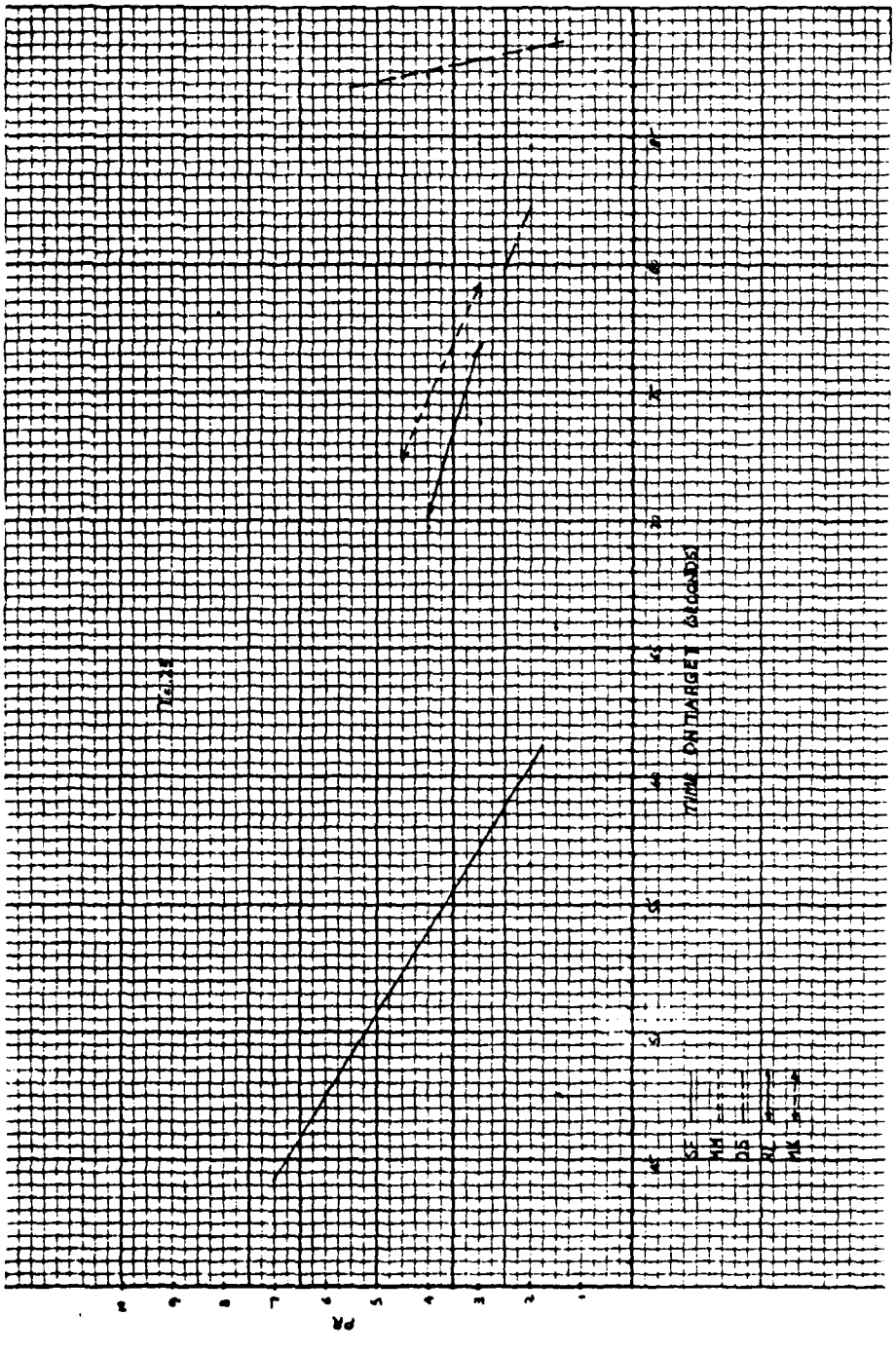


Fig 13. PR vs Time on Target (Sum of Sine Waves)

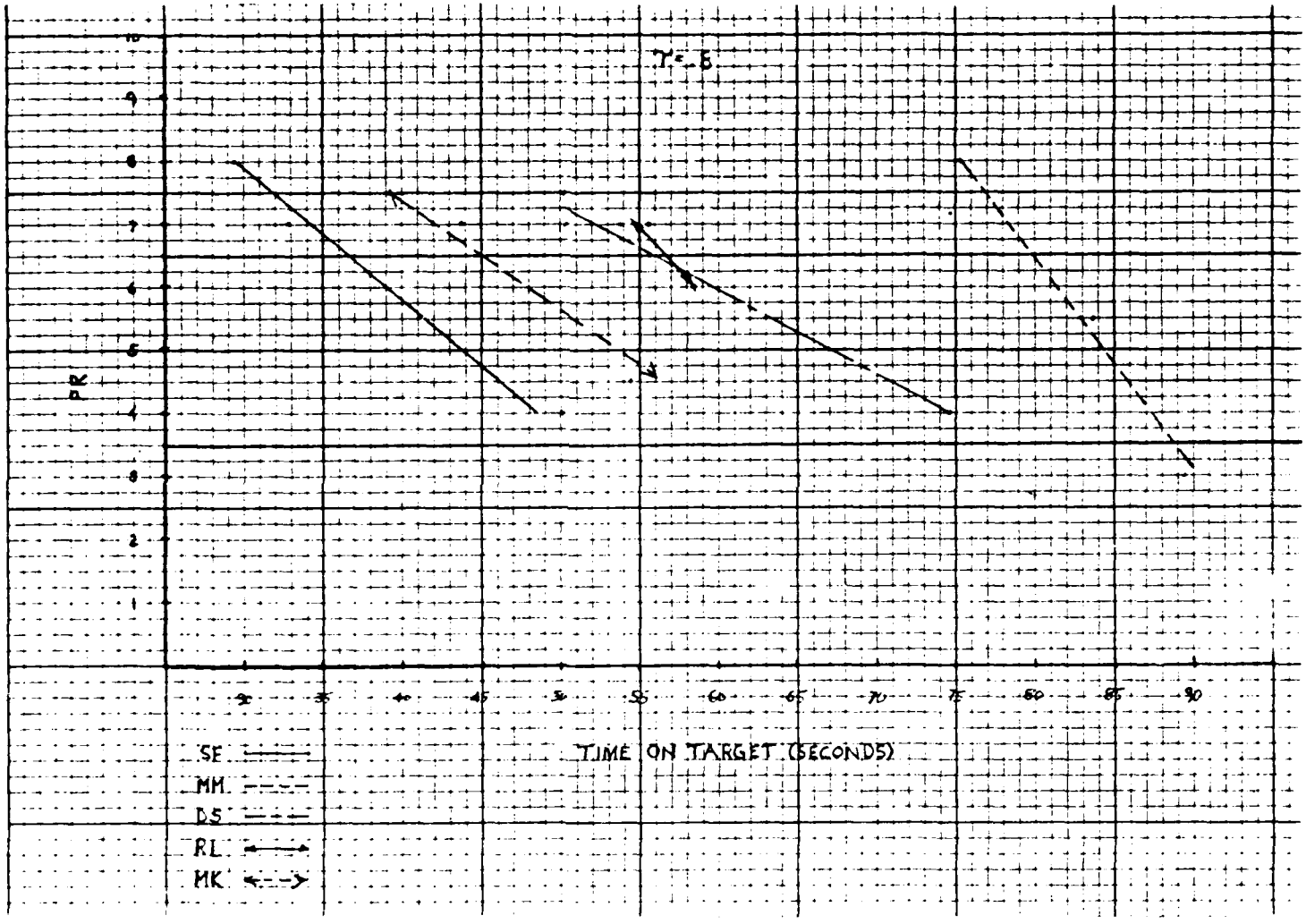


Fig 14. PR vs Time on Target (Sum of Sine Waves)

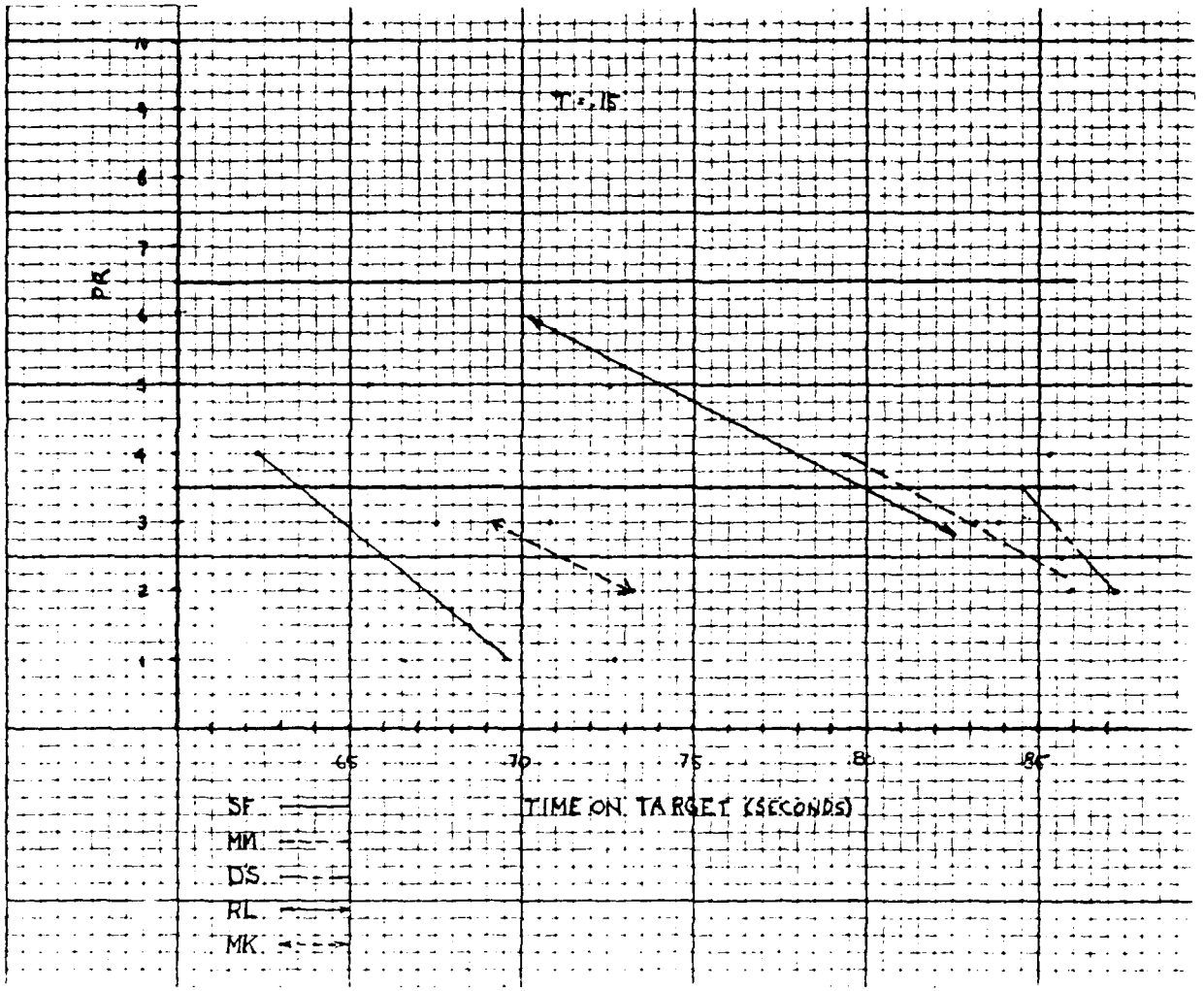


Fig 15. PR vs Time on Target (Sum of Sine Waves)

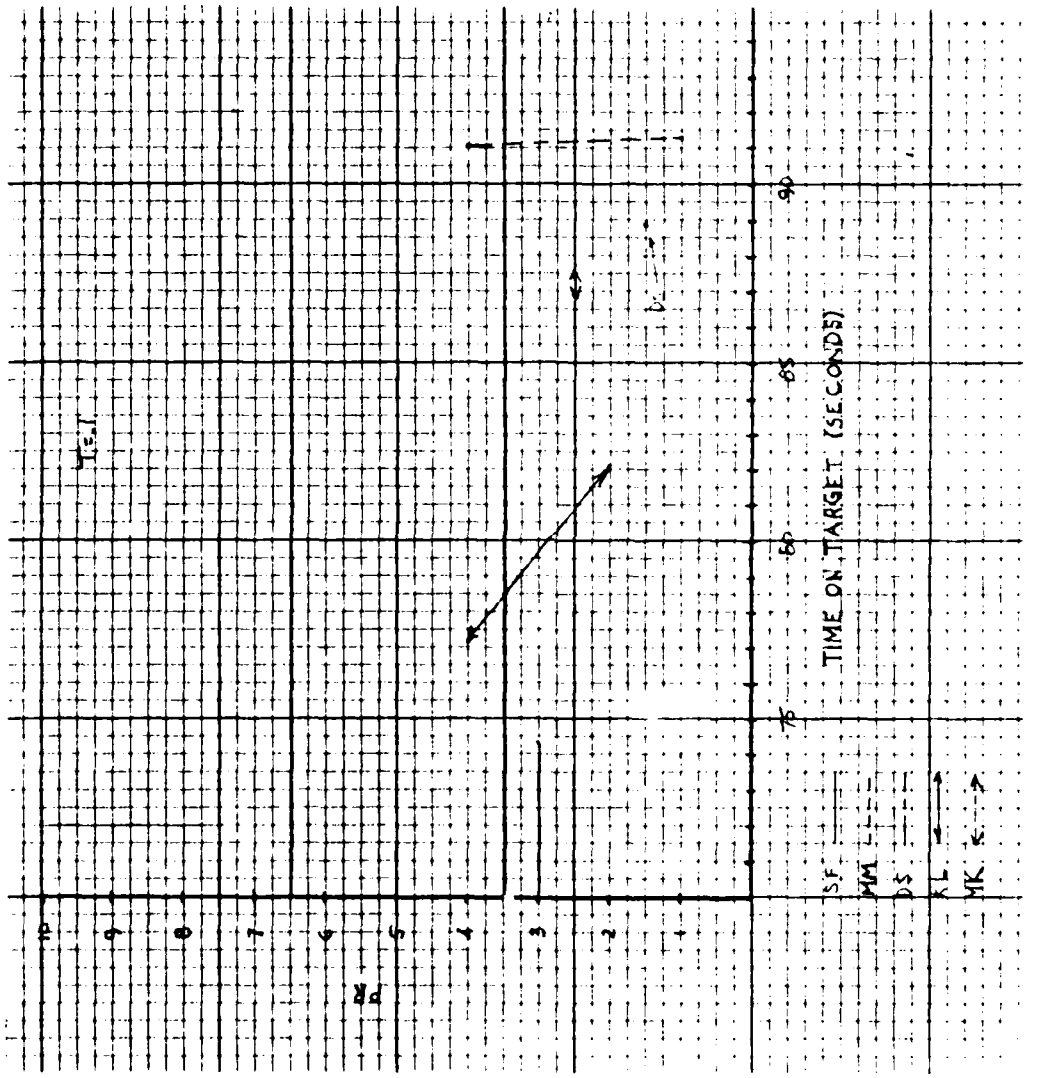


Fig 16. PR vs Time on Target (Sum of Sine Waves)

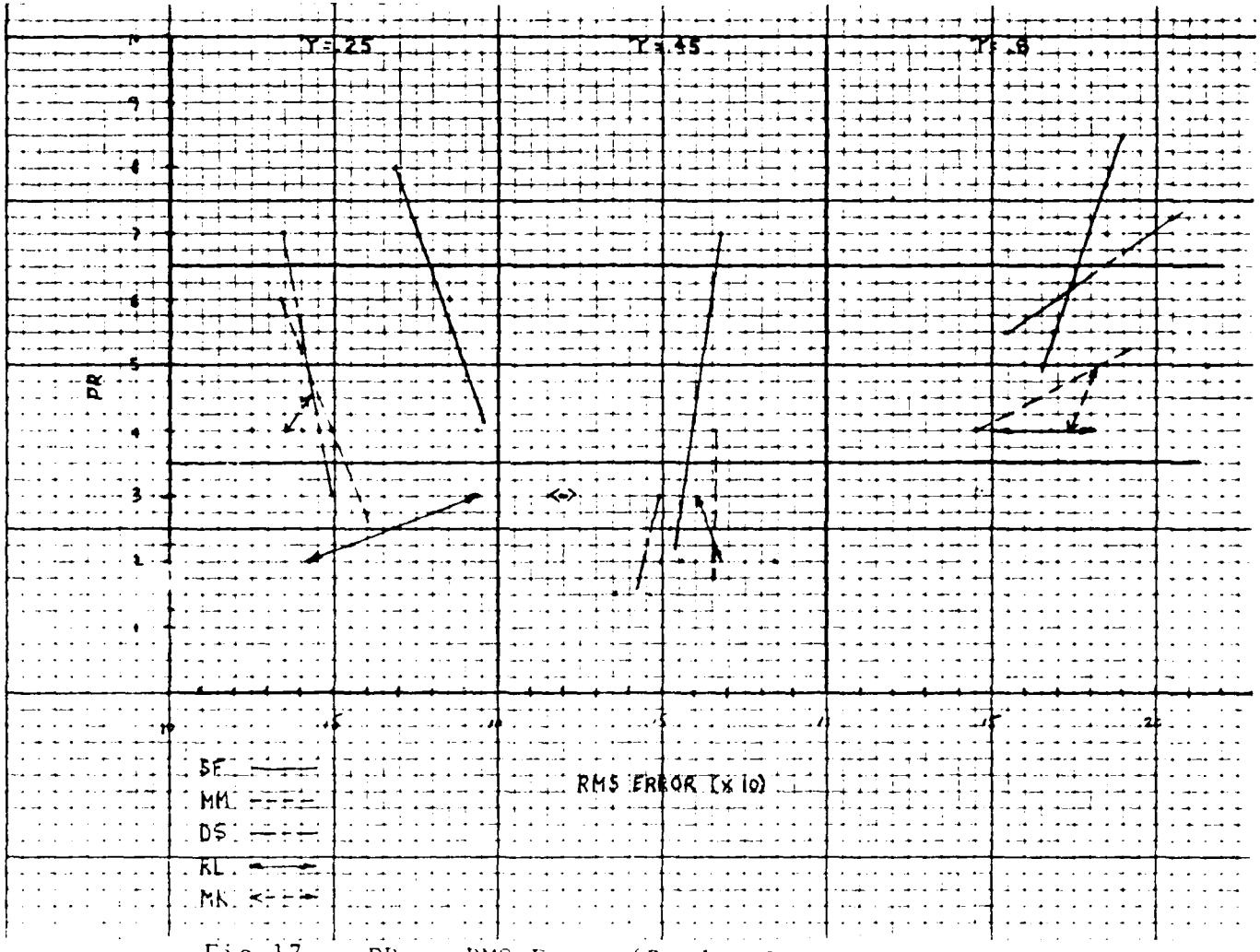


Fig 17. PR vs RMS Error (Random Step)

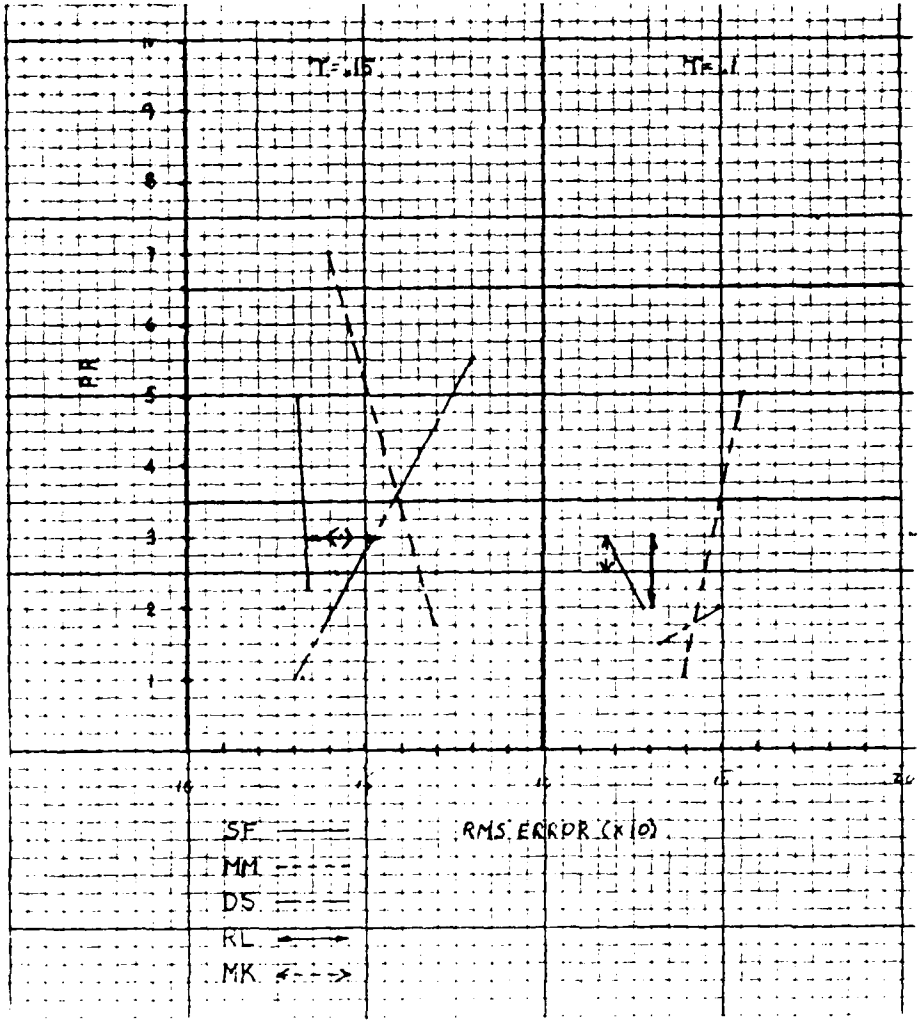


Fig 18. PR vs RMS Error (Random Step)

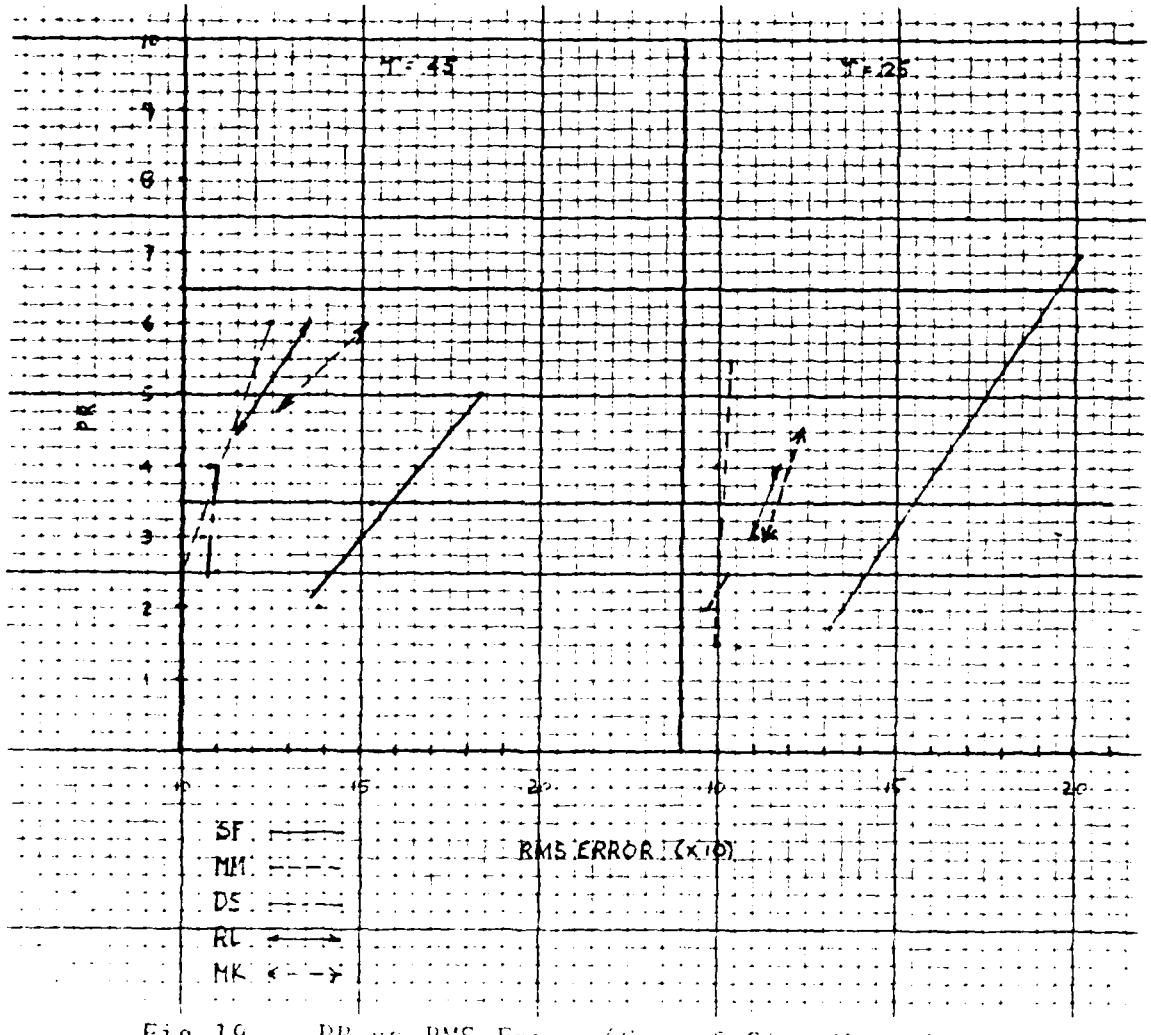


Fig 19. PR vs RMS Error (Sum of Sine Waves)

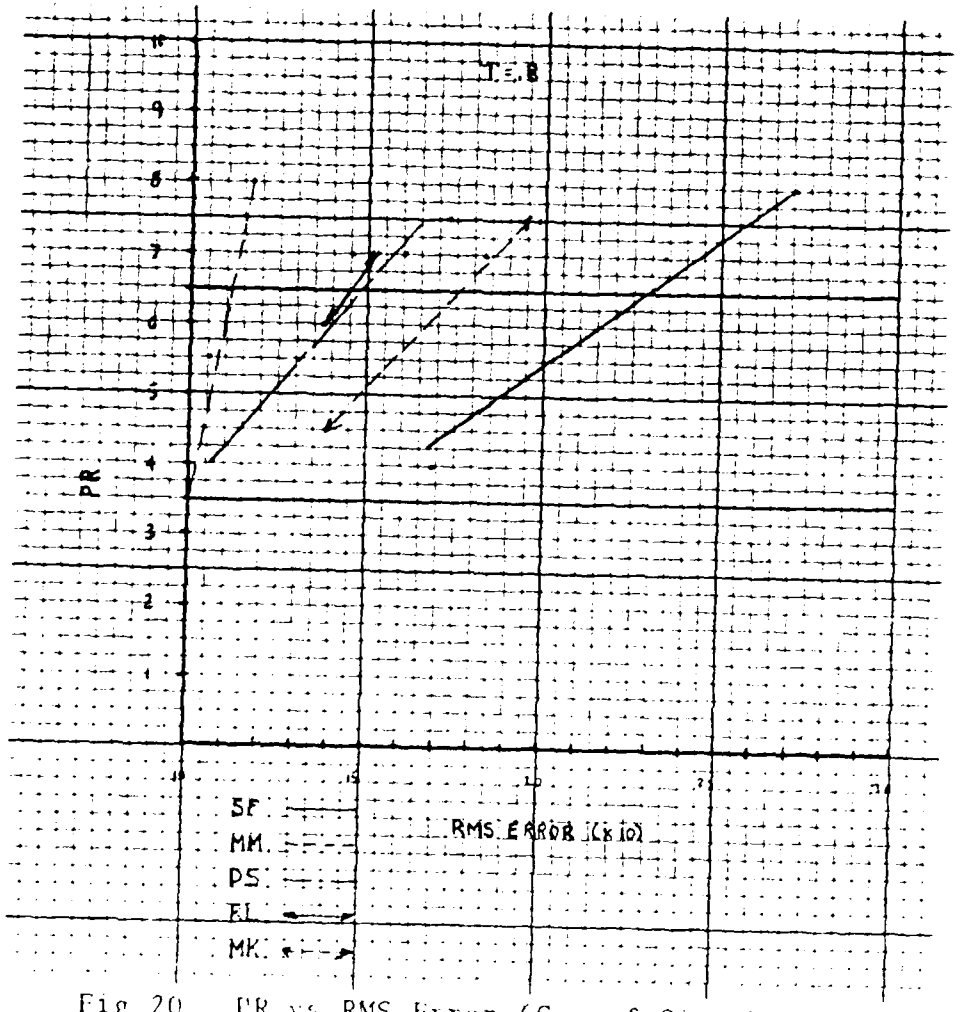


Fig 20. PR vs RMS Error (Sum of Sine Waves)

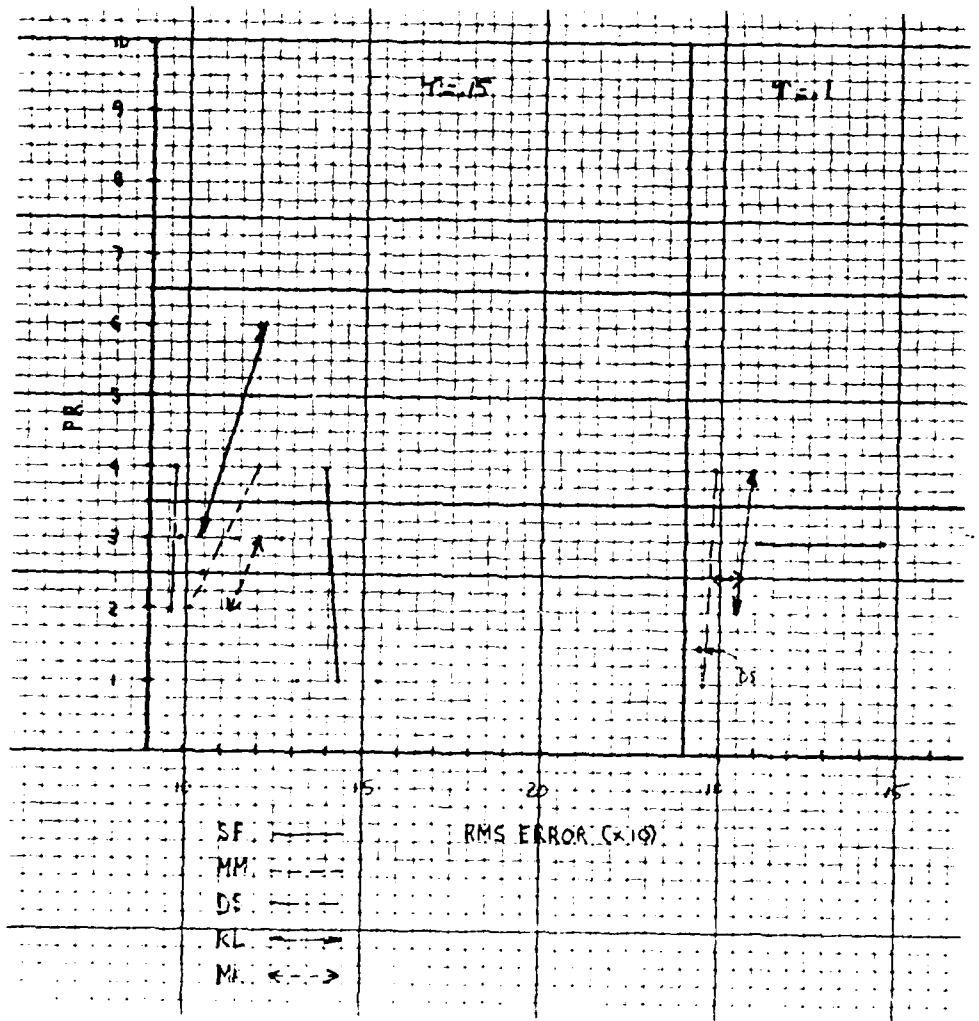


Fig 21. PR vs RMS Error (Sum of Sine Waves)

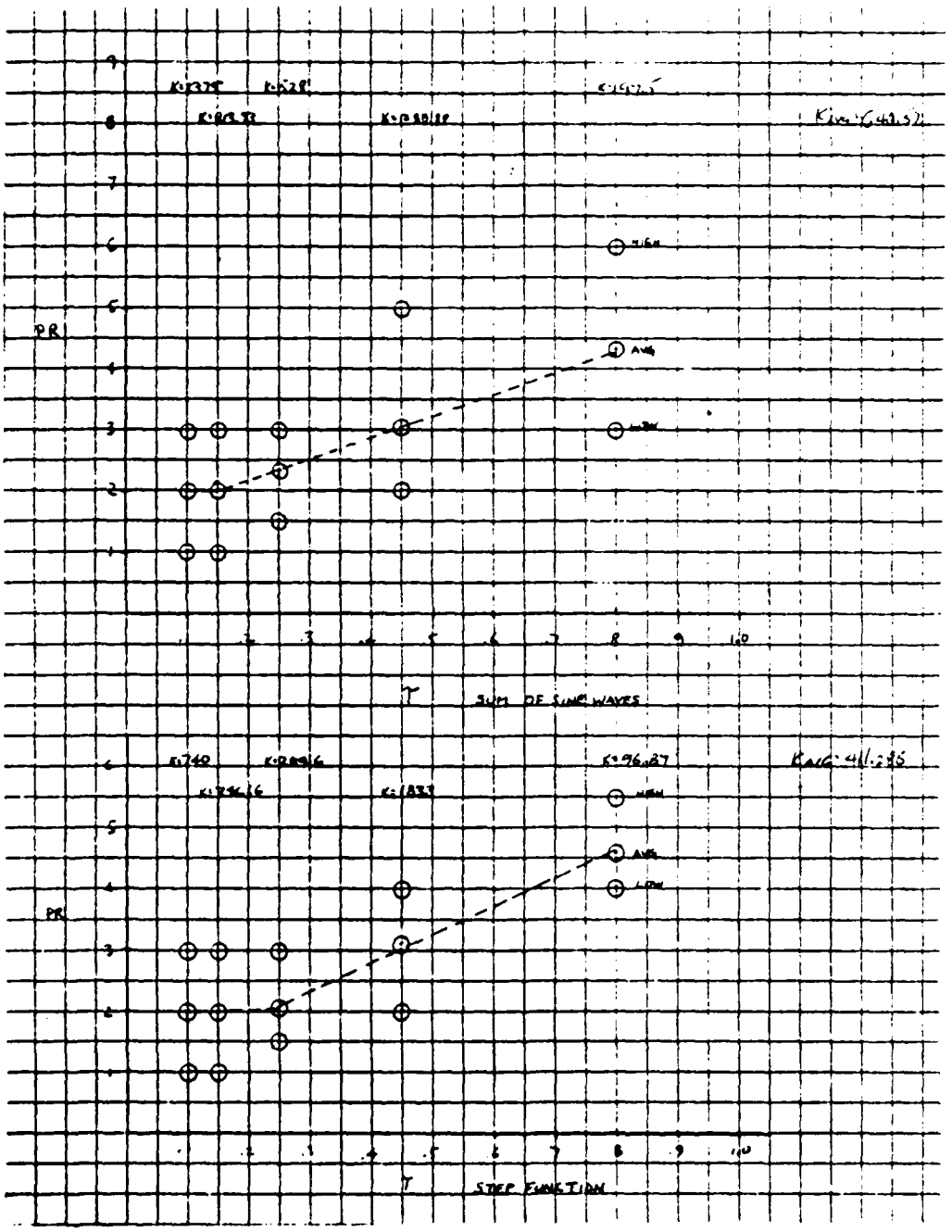


Fig 22. Pilot Rating vs Time Delay

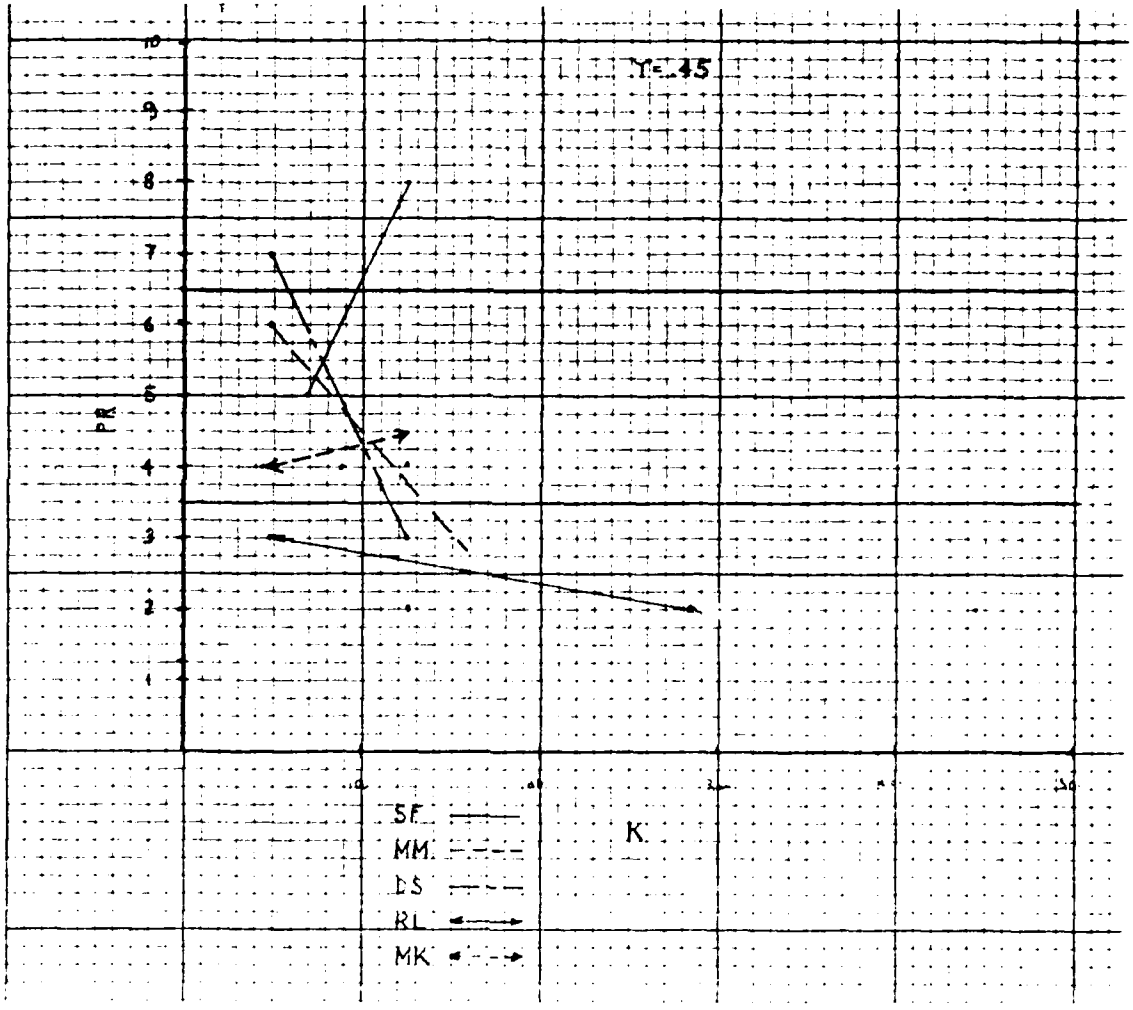


Fig 23. PR vs K (Random Step)

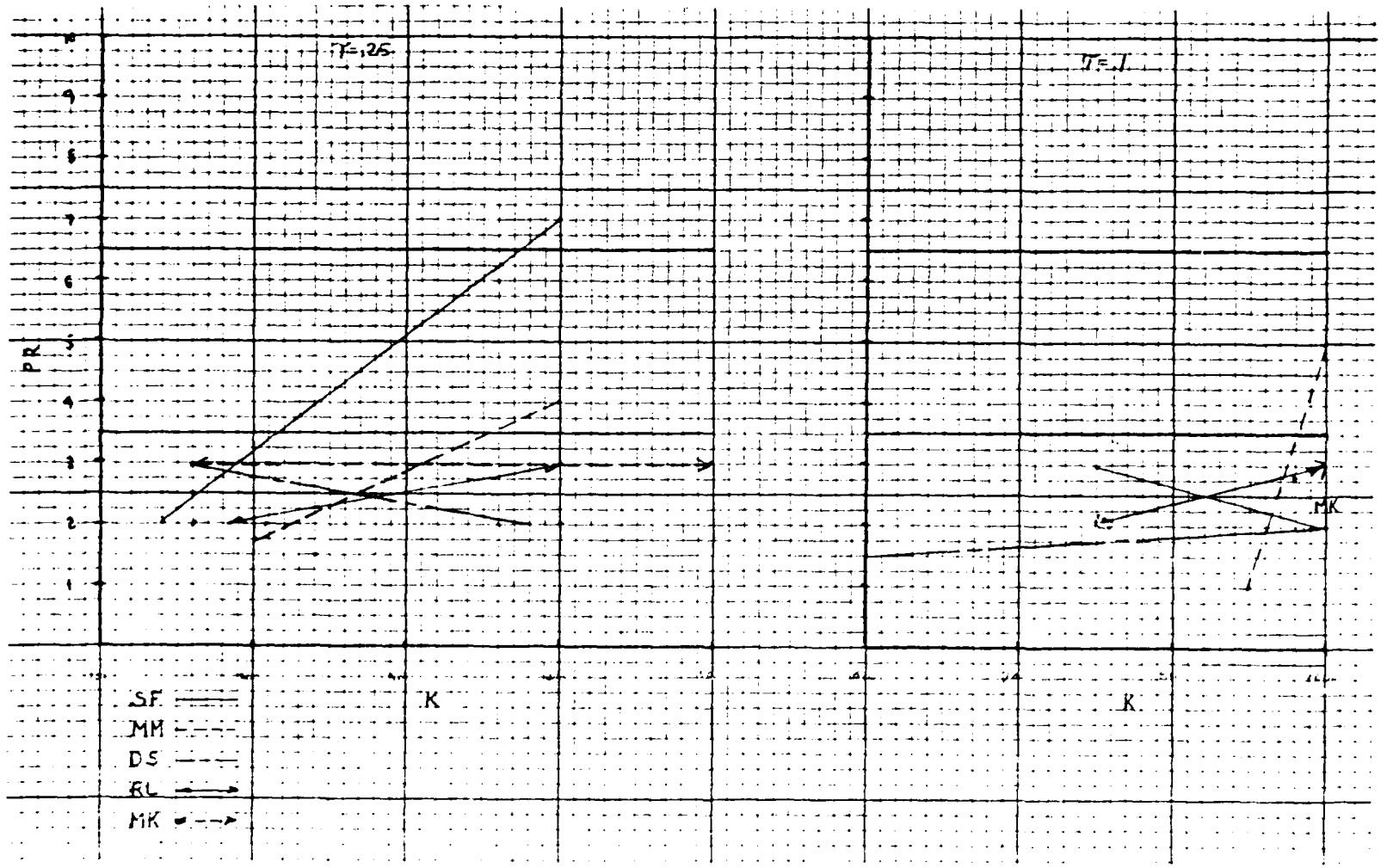


Fig 24. PR vs K (Random Step)

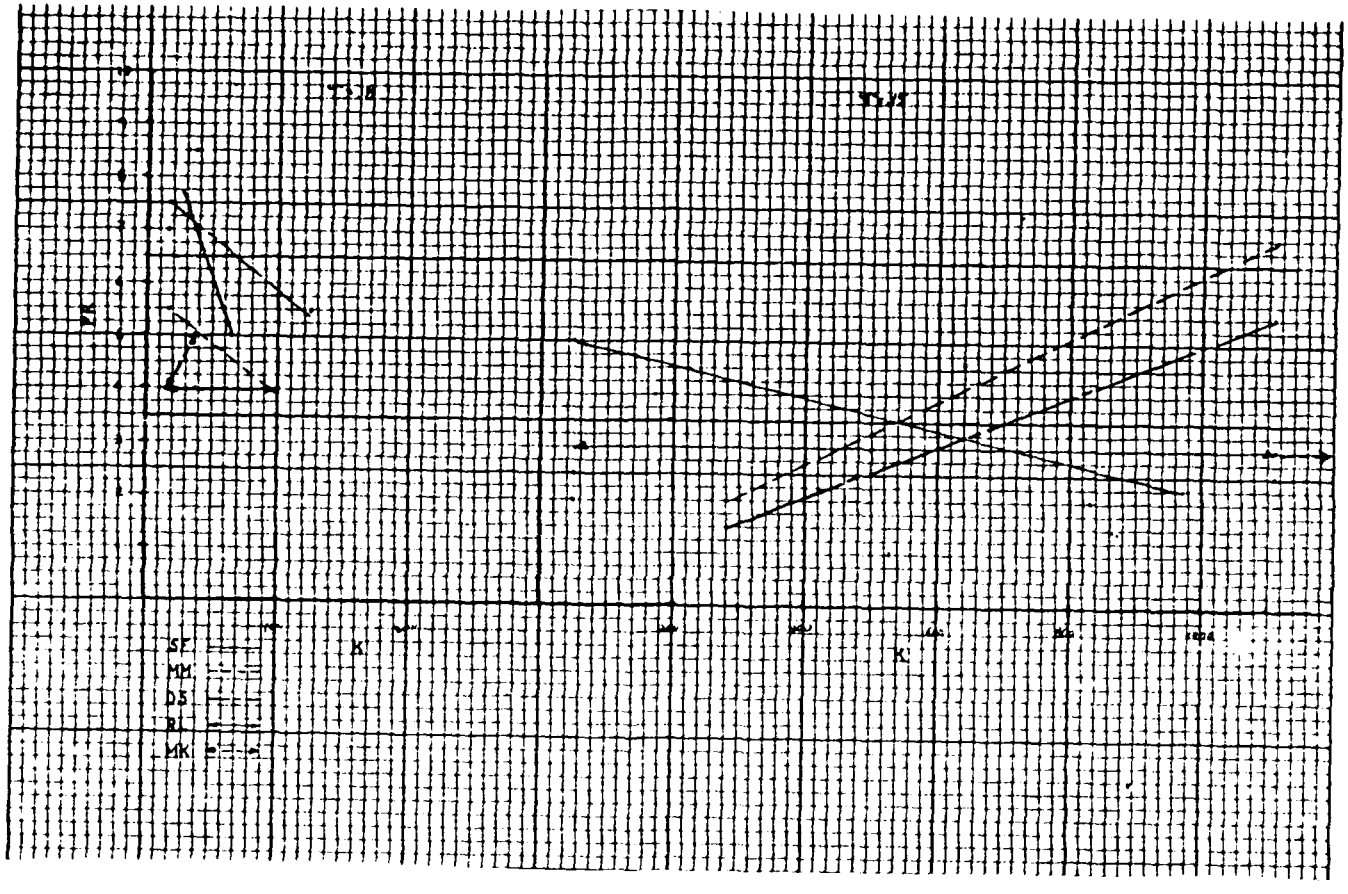


Fig 25. PR vs K (Random Step)

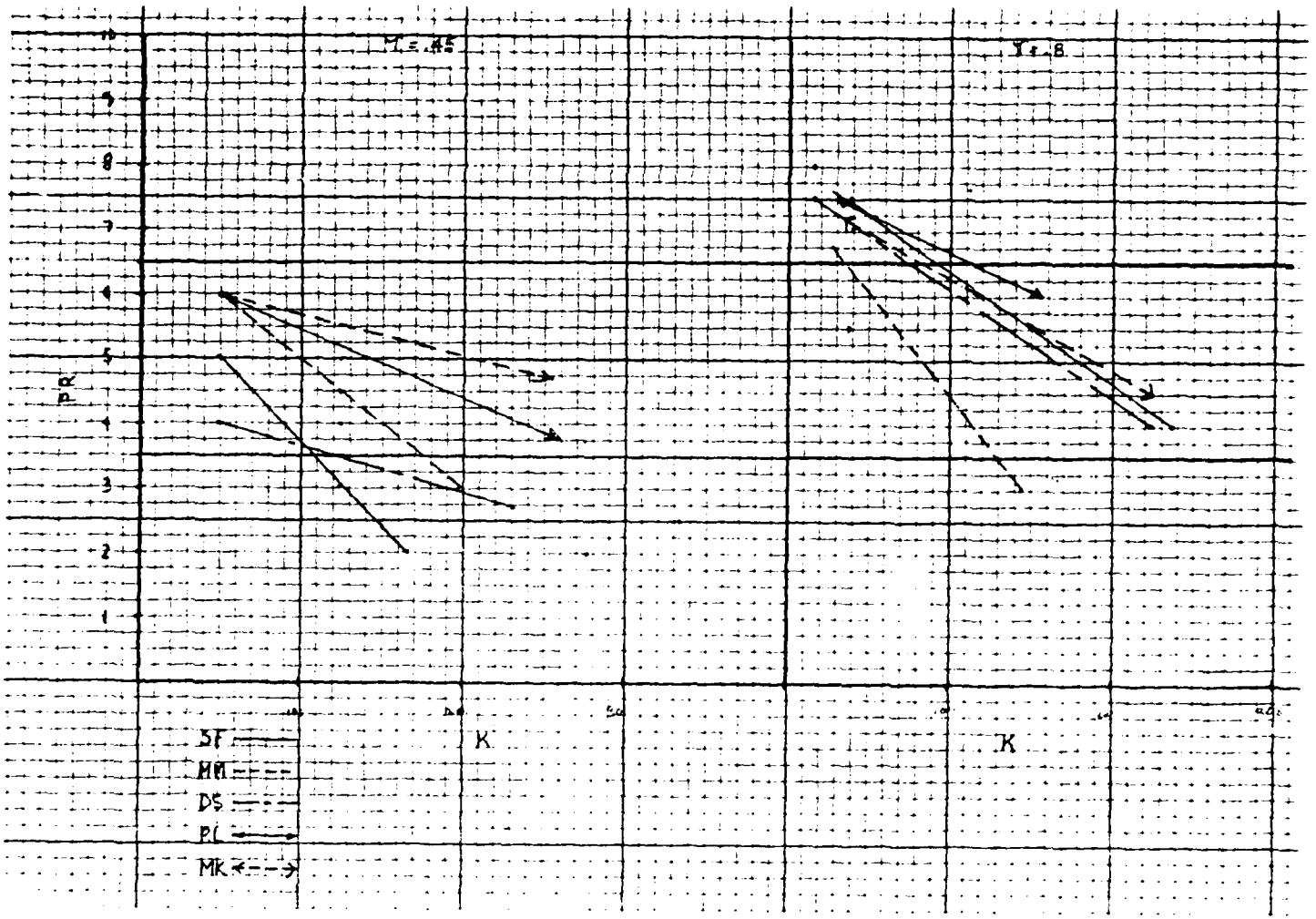


Fig 26. PR vs K (Sum of Sine Waves)

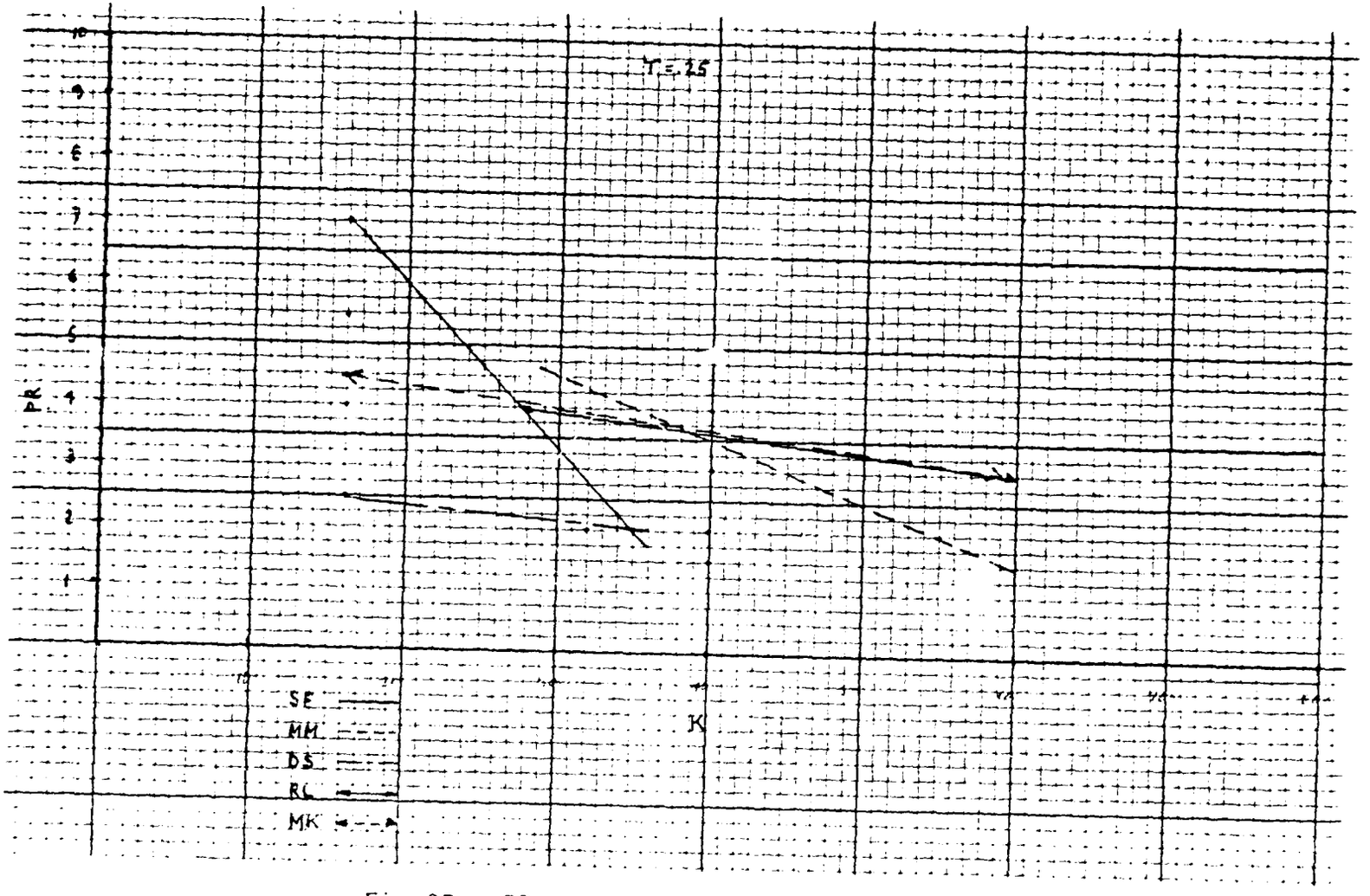


Fig 27. PR vs K (Sum of Sine Waves)

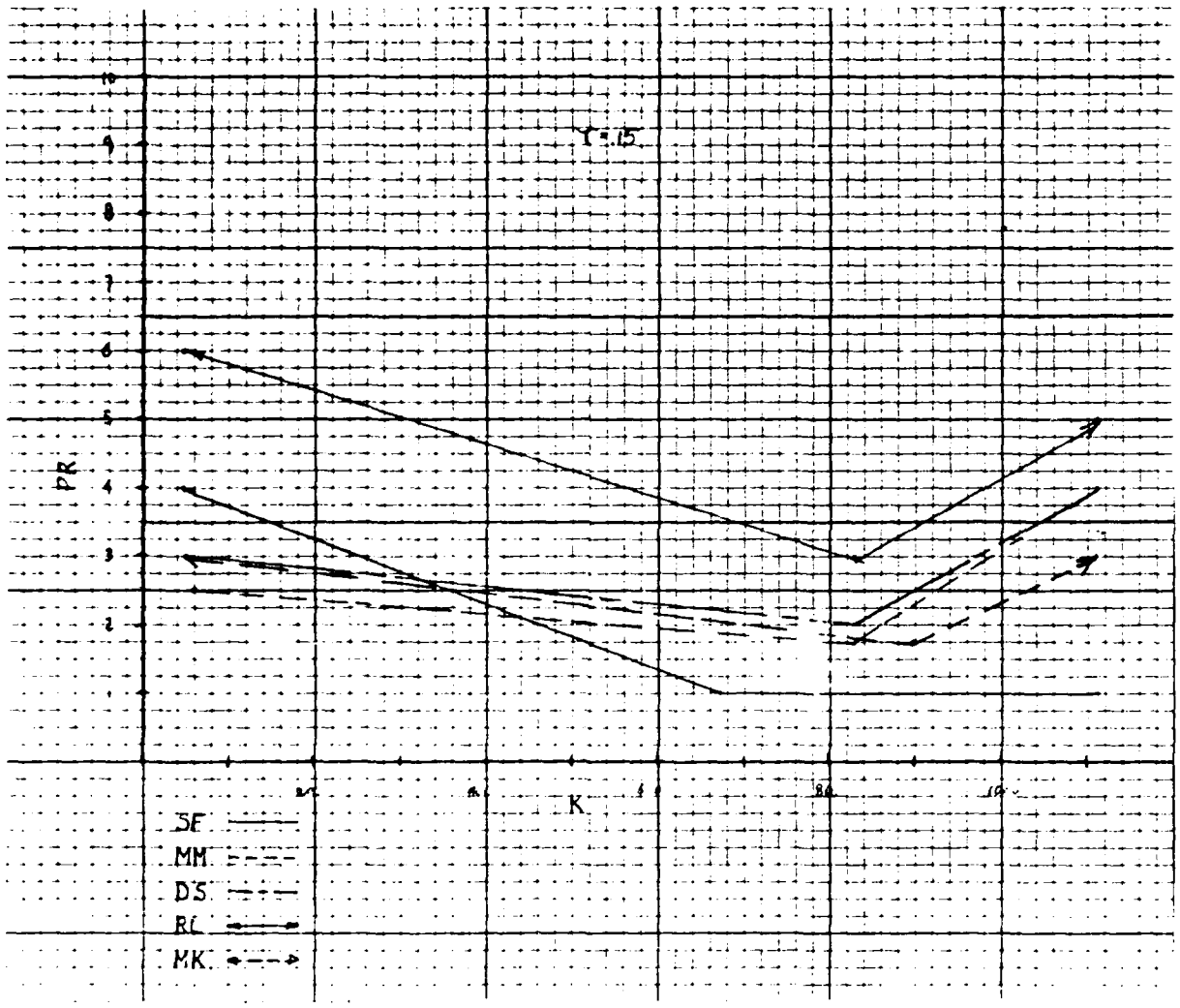


Fig 28. PR vs K (Sum of Sine Waves)

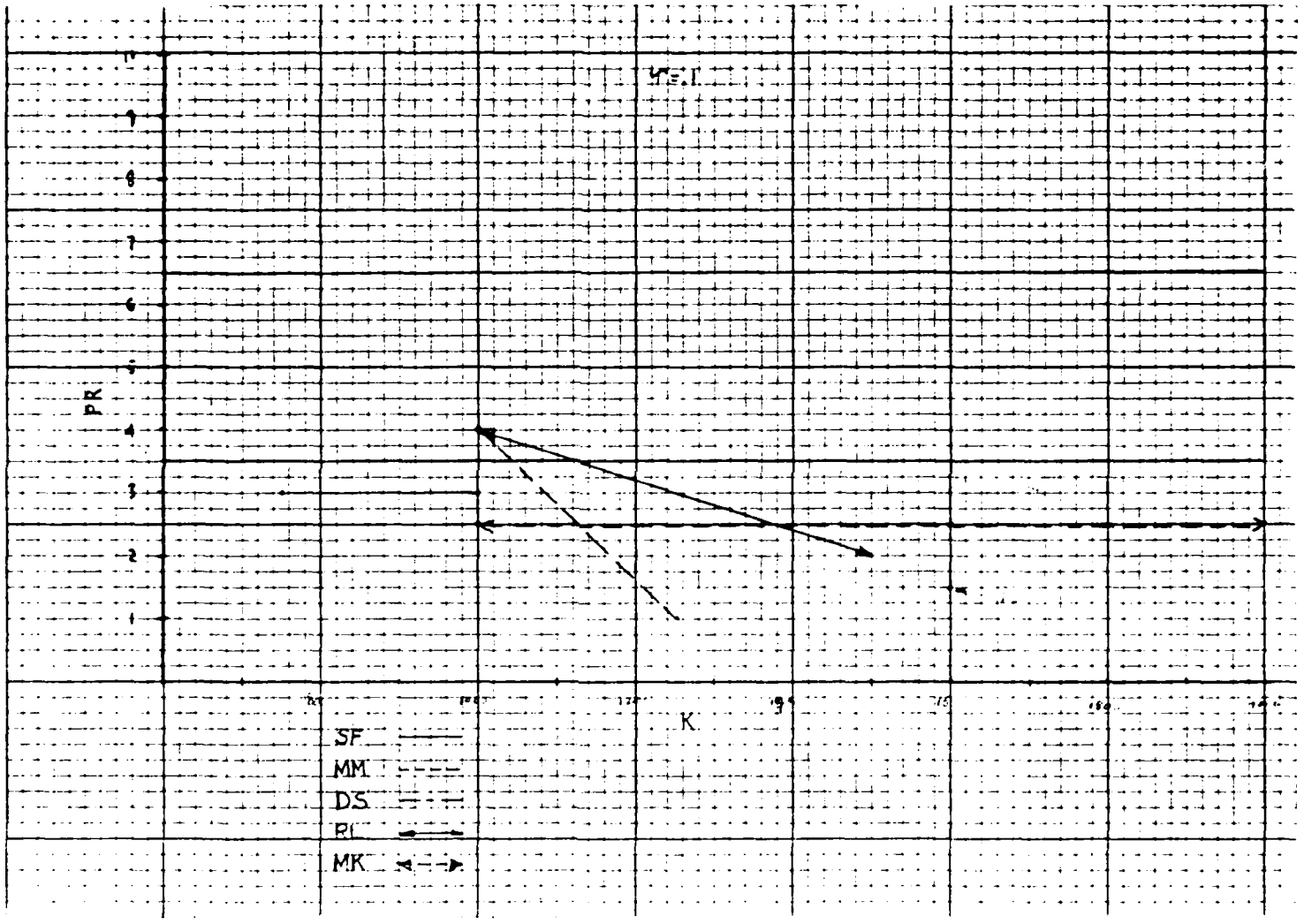


Fig 29. PR vs K (Sum of Sine Waves)

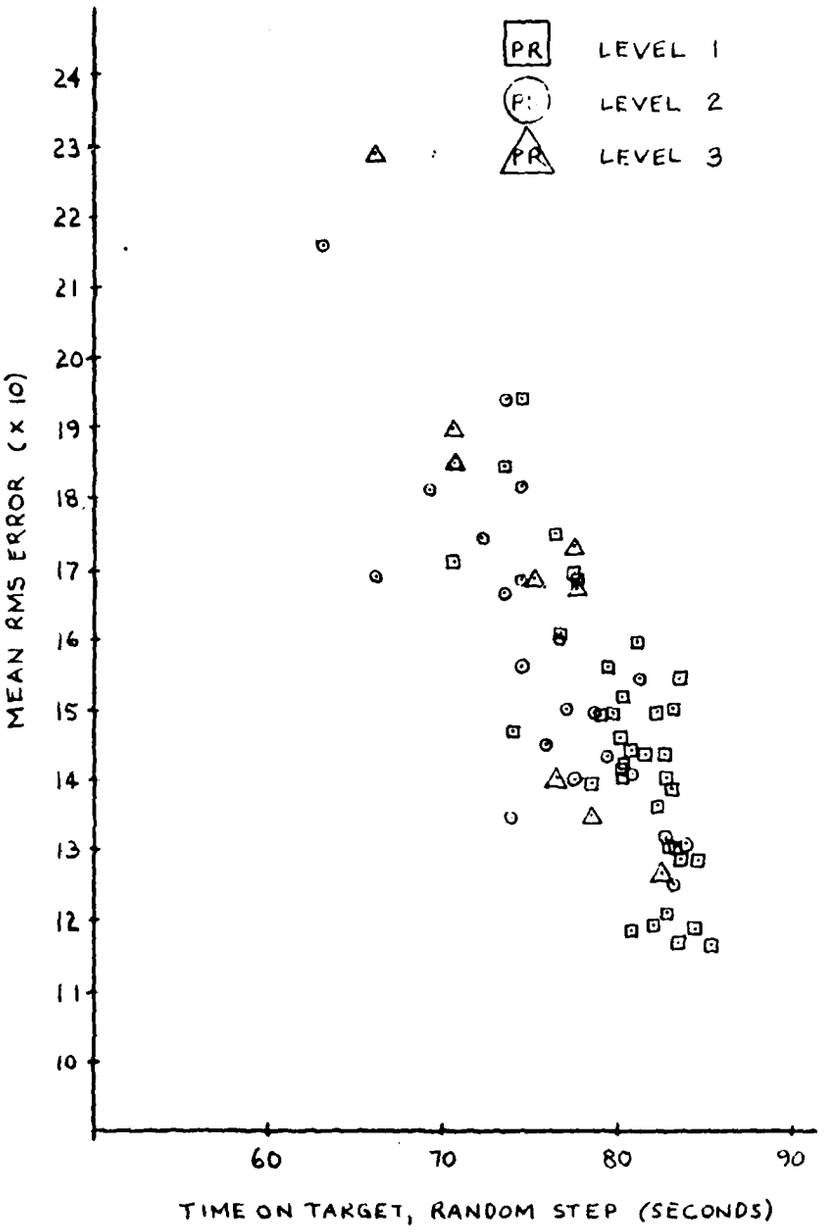


Fig 30. Mean RMS Error vs Time on Target

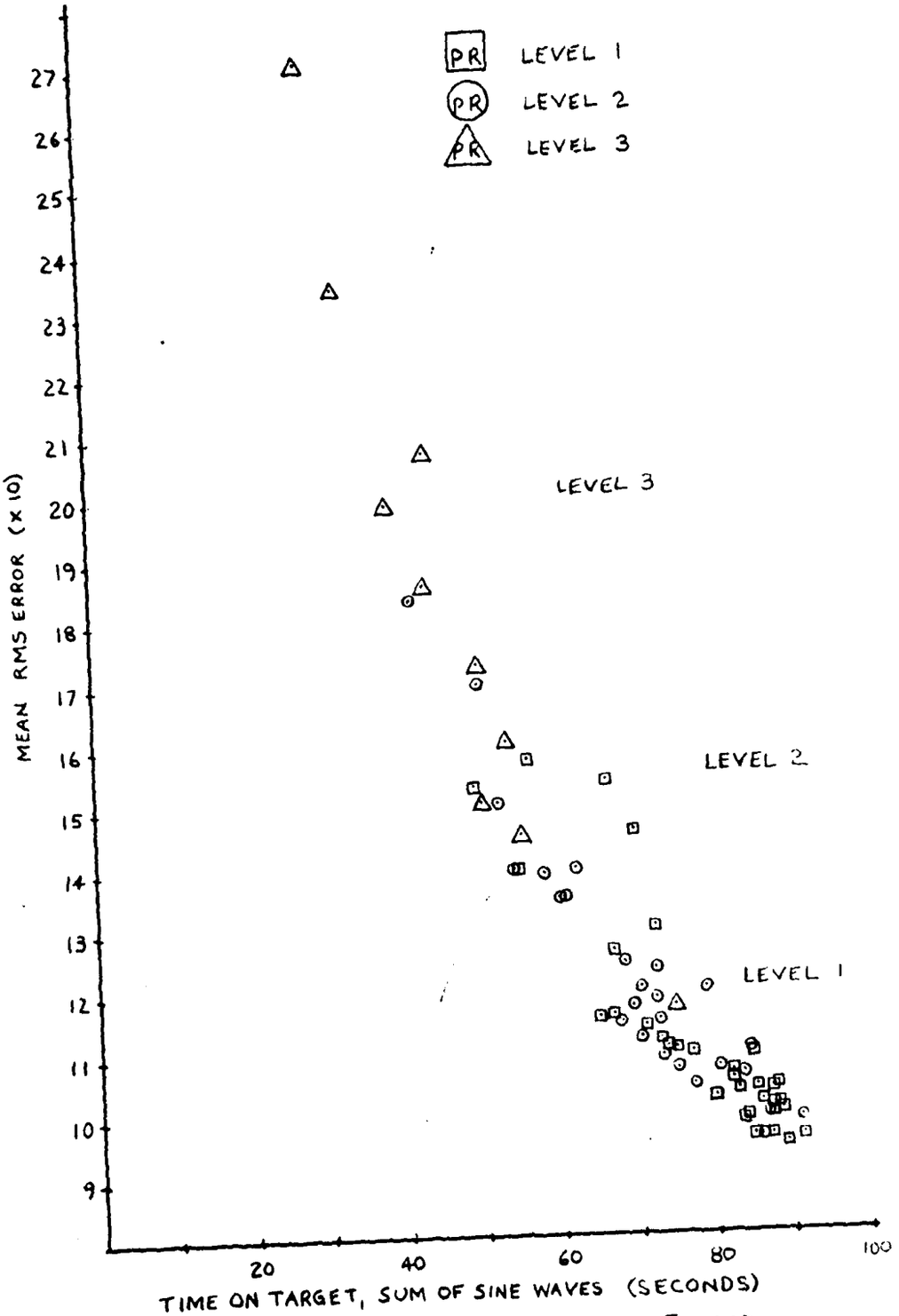


Fig 31. Mean RMS Error vs Time on Target

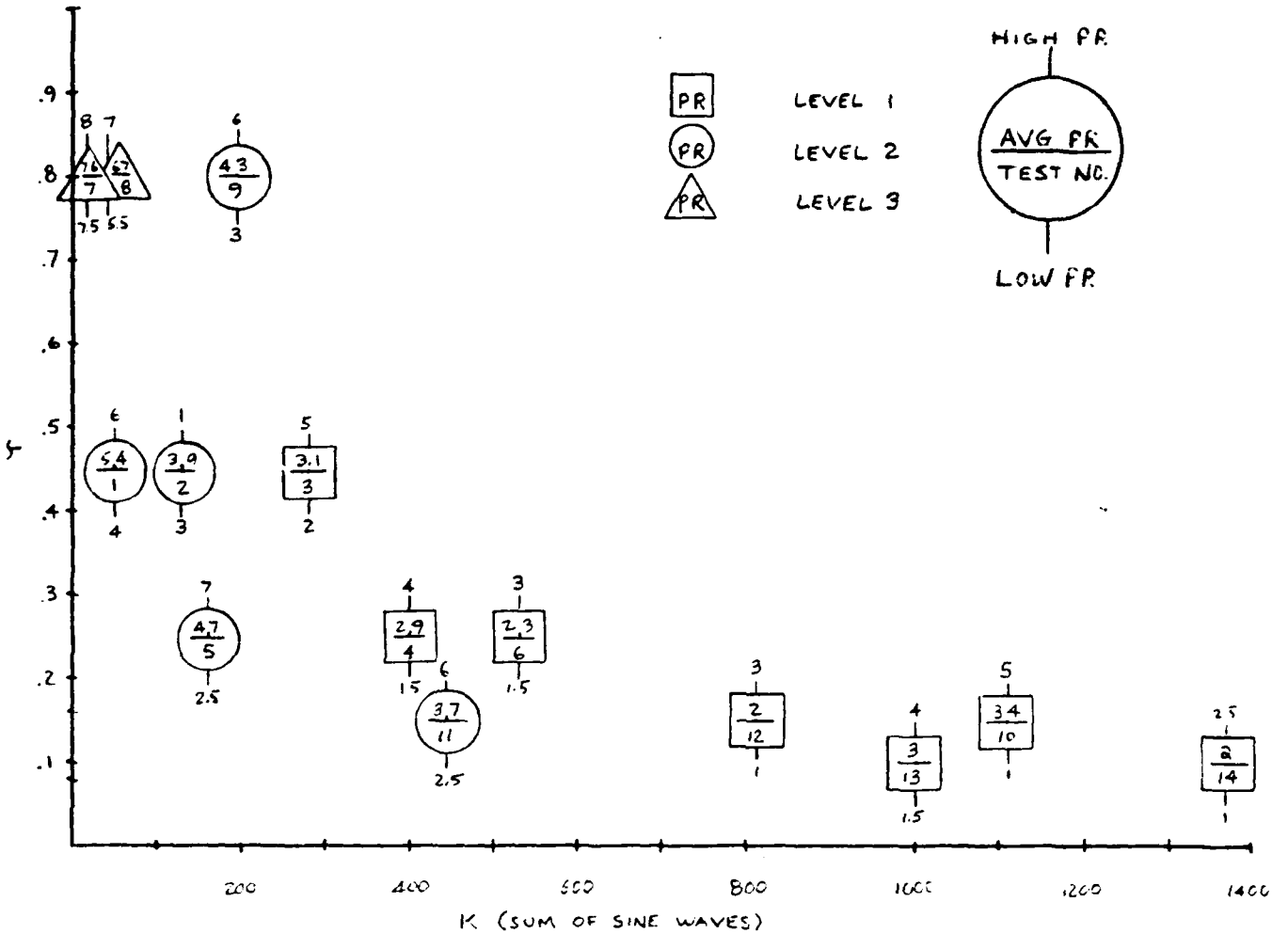


Fig 32. τ vs K (Sum of Sine Waves)

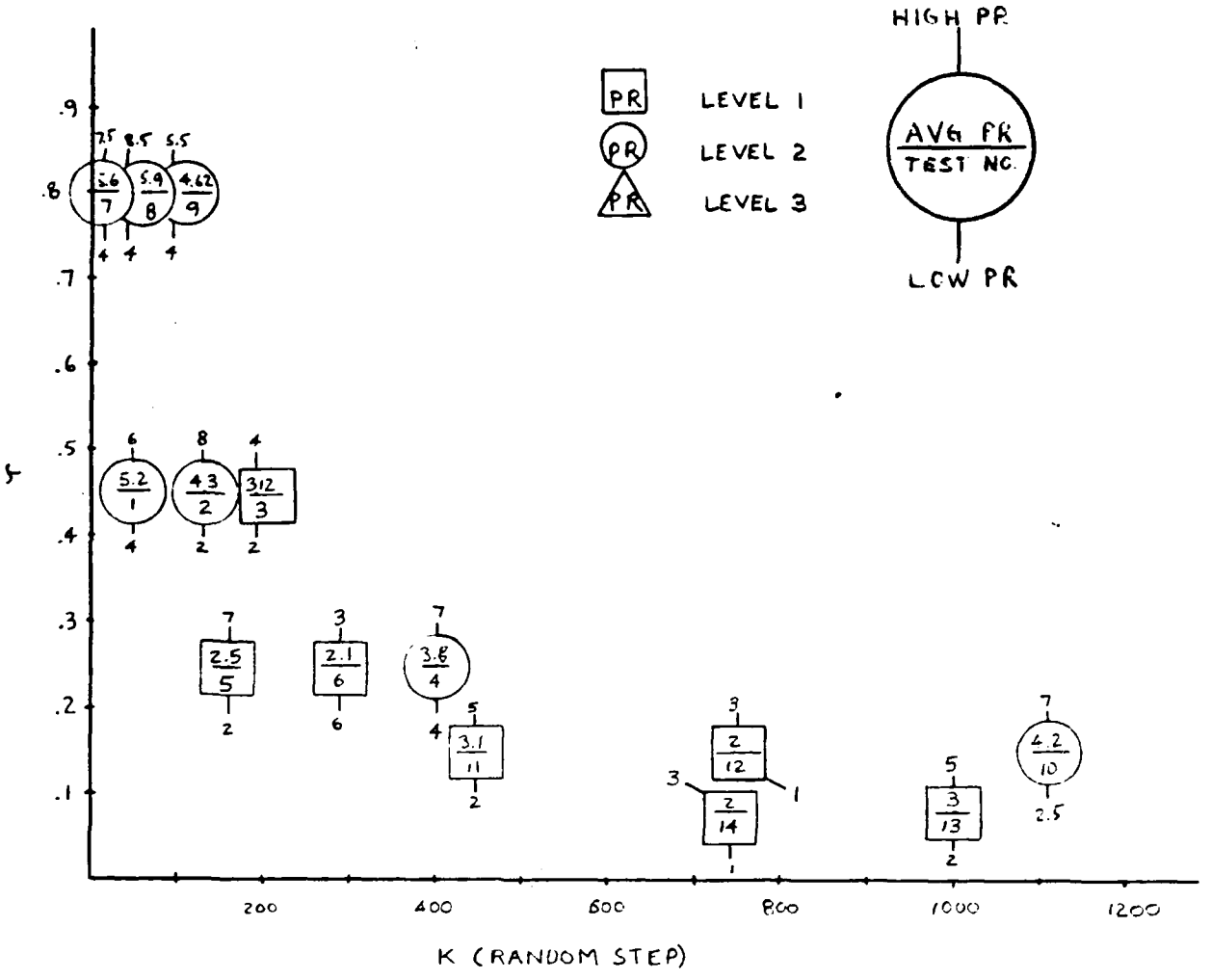


Fig 33. τ vs K (Random Step)

IV. Summary, Conclusions and Recommendations

The purposes of this thesis were to determine what effect the type of command input has on the pilot rating during a roll tracking task with various time constants, determine the effect of stick sensitivity on pilot rating for those same cases, and collect data on the pitch axis to compare with high order systems. Early in the study a problem (still not resolved) arose with the pitch simulation.Data collection continued with the roll axis simulation. After all the roll data were taken, an algebraic error was discovered in the roll simulation. An extra factor was not accounted for. This factor changed all of the stick gain results. However, the data were recalculated to account for the newly discovered factor; the revised data showed that some of the configurations tested are not attainable in today's normal aircraft. Instead of discarding the data, the results were used to show trends and form conclusions based on all the data. These trends are considered valid.

In short, all of the random step data were inconsistent. When all three performance measures were used, there were no correlations that could be definitely made between the data. For the sum of sine waves data, there are many signs of trends between performance measures and the data were consistent, even between different pilots. The

subjects continually gave low pilot ratings for high time on targets, low RMS errors, and high stick gains. In addition, subjects optimized their stick gains when time delay decreased. Finally, all the subjects preferred "K/s-like" dynamics as the time delay was decreased. This conclusion is in direct conflict with both Monagan and Chalk.

It should be remembered that Monagan and Chalk's studies were on an actual aircraft with motion. The current studies were performed on a fixed-base simulator. The obvious difference between the two are the effects of motion and actual flight. These factors cannot be accounted for in the simulator. Clearly further study with more pilots and a motion simulator is needed before assuming any definite conclusions. In addition, it is recommended that any future flight tests include sum of sine waves command signals, and the experimenters compare these test results with the other test data.

This thesis did bring out the fact that a sum of sine waves command signal (highest frequency 2.54 radians/sec) is preferred by subjects and does lead to K/s-like dynamics for time delay between 0.1 and 0.8 seconds as most desirable, at least when no motion is present. Thus, prevailing theories are still appropriate and one might question the conclusions of both Chalk and Monagan because of the inconsistencies associated with the step data. Furthermore, it is recommended that future inflight testing with the NT-33 include sum of sine waves command signals.

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APPENDIX A

CALIBRATION OF THE CONTROL STICK AND ROLL SIMULATION

As mentioned previously, a control stick obtained from bench stock was used in these experiments. However, there was no documentation on the control stick. This particular stick was used only because the pilots had no experience with a force stick, the only other stick available. The pilots wanted another feedback cue other than just the visible display on the scope, and a force stick could not accommodate the pilots since it did not move. The control vtick used was free to move plus or minus 25 degrees in the roll axis and plus or minus 20 degrees in the pitch axis. By judging the movement on the stick with the W on the scope, a pilot can gage his force necessary to follow the command signal. In addition, all pilots have had experience with a moveable control stick and none with a force stick, otherwise additional training would have been required.

Stick Calibration

The items used to calibrate the stick were assorted weights, string, tape, protractor grid, bearing and a needlepoint. The stick was secured to a table to insure no movement of the base. The string was attached to the center of the grip and placed over a bearing which was rigidly

attached to the table. The end of the cord had a loop to allow for the weights (Fig A-1). As weights were placed on the end of the string, the handle would deflect. A protractor grid was rigidly placed around the axis of movement and a needlepoint was attached to the same axis. As the handle deflected, a reading in degrees was made. This procedure was used for both axes. Tables A-1 and A-2 show the tabulated data, and Figs A-2 and A-3 show the graphed data.

TABLE A-1

Roll Axis

Left		Right	
Pounds	Degrees	Pounds	Degrees
0.88	0.5	0.88	0.5
0.99	0.5	0.99	1.0
1.10	0.5	1.10	1.5
1.14	0.5	1.14	7.0
1.21	1.0	1.21	13.5
1.32	2.0	1.32	25.0
1.54	6.0		
1.64	20.0		
1.66	25.0		

TABLE A-2

Pitch Axis

Forward		Aft	
Pounds	Degrees	Pounds	Degrees
		1.32	0.5
1.54	0.5	1.54	0.5
1.65	0.5	1.65	0.5
1.76	0.5	1.76	0.5
1.98	1.0	1.98	1.0
2.20	4.0	2.20	3.5
2.31	7.0	2.31	7.5
2.42	12.5	2.42	13.5
2.64	19.0	2.64	19.0
2.68	20.0	2.68	20.0

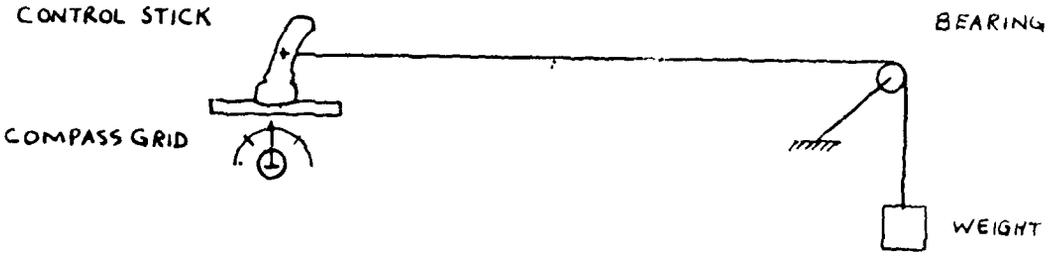


Fig A-1a. Stick Calibration Setup

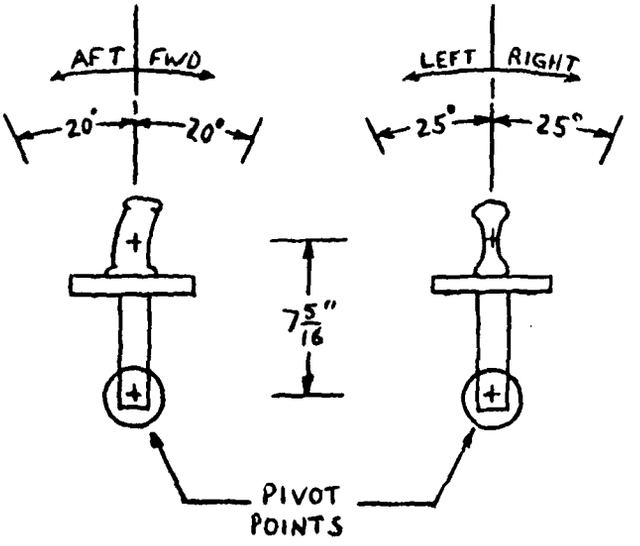


Fig A-1b. Stick Dimensions and Travel

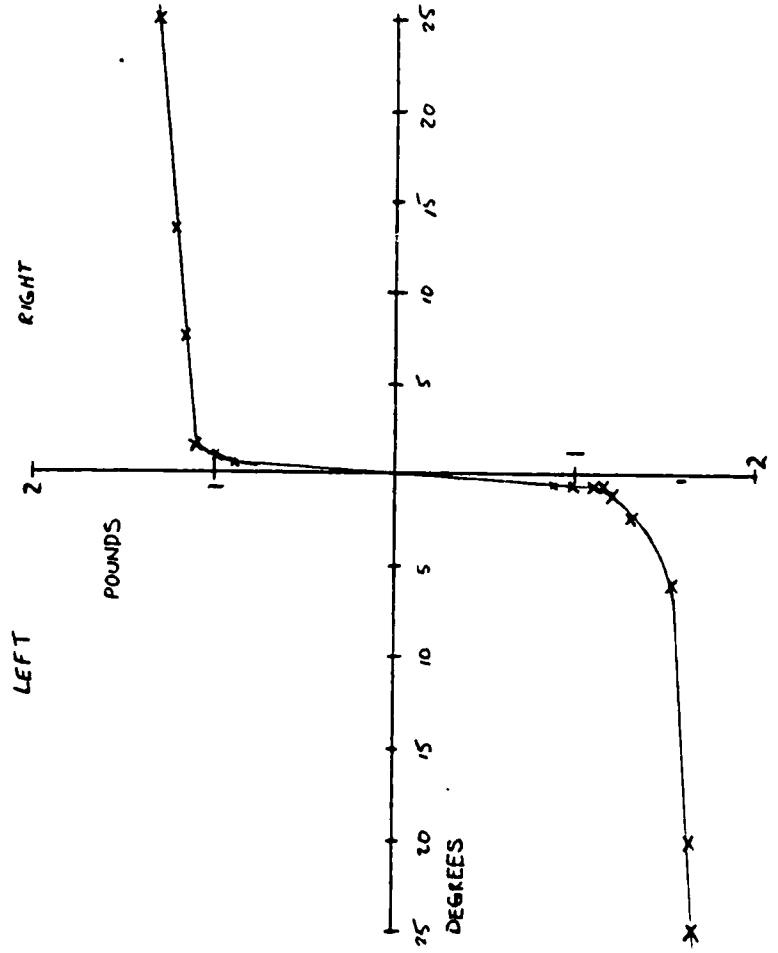


Fig A-2. Roll Axis

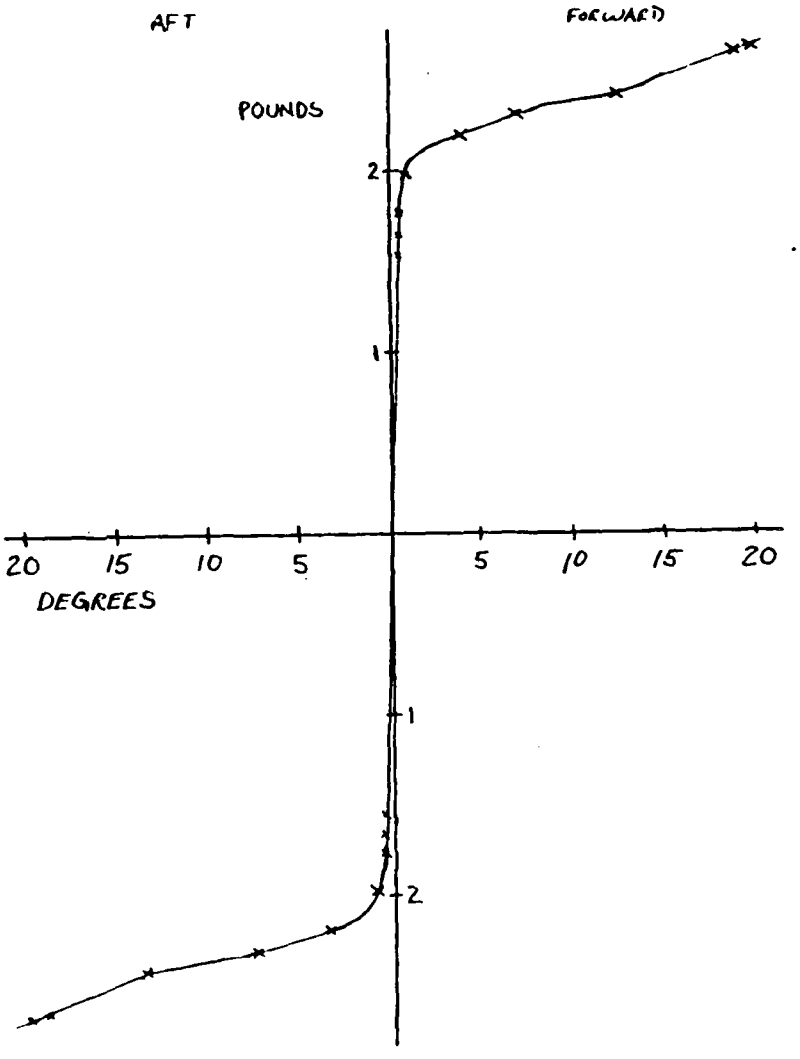


Fig A-3. Pitch Axis

Stick Wiring

Since there were no wiring diagrams of the control stick, one was drawn up and is shown in Fig A-4.

Simulation Calibration

This calibration was actually used to verify that the same values of P_{SS}/F_{AS} in Monagan's paper were used for this thesis. This calibration led to the discovery that the experiments did not duplicate Monagan precisely. The potentiometer controlling the value of K had an extra τ factor which was not taken into account. The procedure for the calibration removed the control stick and replaced it with a signal of one volt for one second. This procedure was repeated for every different value of τ and K. The output of integrator 34 (Φ) was then measured with a digital voltmeter. Table A-3 shows the calculated and measured results for P_{SS}/F_{AS}.

TABLE A-3

Calculated and Measured P_{SS}/F_{AS}

Calculated			Measured	
τ	K	P_{SS}/F_{AS}	Φ	P_{SS}/F_{AS}
sec	$\frac{deg/sec^2}{lb}$	$\frac{deg/sec}{lb}$	deg	$\frac{deg/sec}{lb}$
0.45	49.38	22.22	0.95	21.83
0.45	123.42	55.54	2.37	54.48
0.25	400.00	100.00	4.14	95.17
0.25	160.00	40.00	1.70	39.08
0.80	15.63	12.50	0.54	12.41
0.80	39.10	31.28	1.34	30.80
0.15	1111.10	166.66	6.92	159.07
0.15	444.44	66.66	2.80	64.36
0.10	1000.00	100.00	4.14	95.17

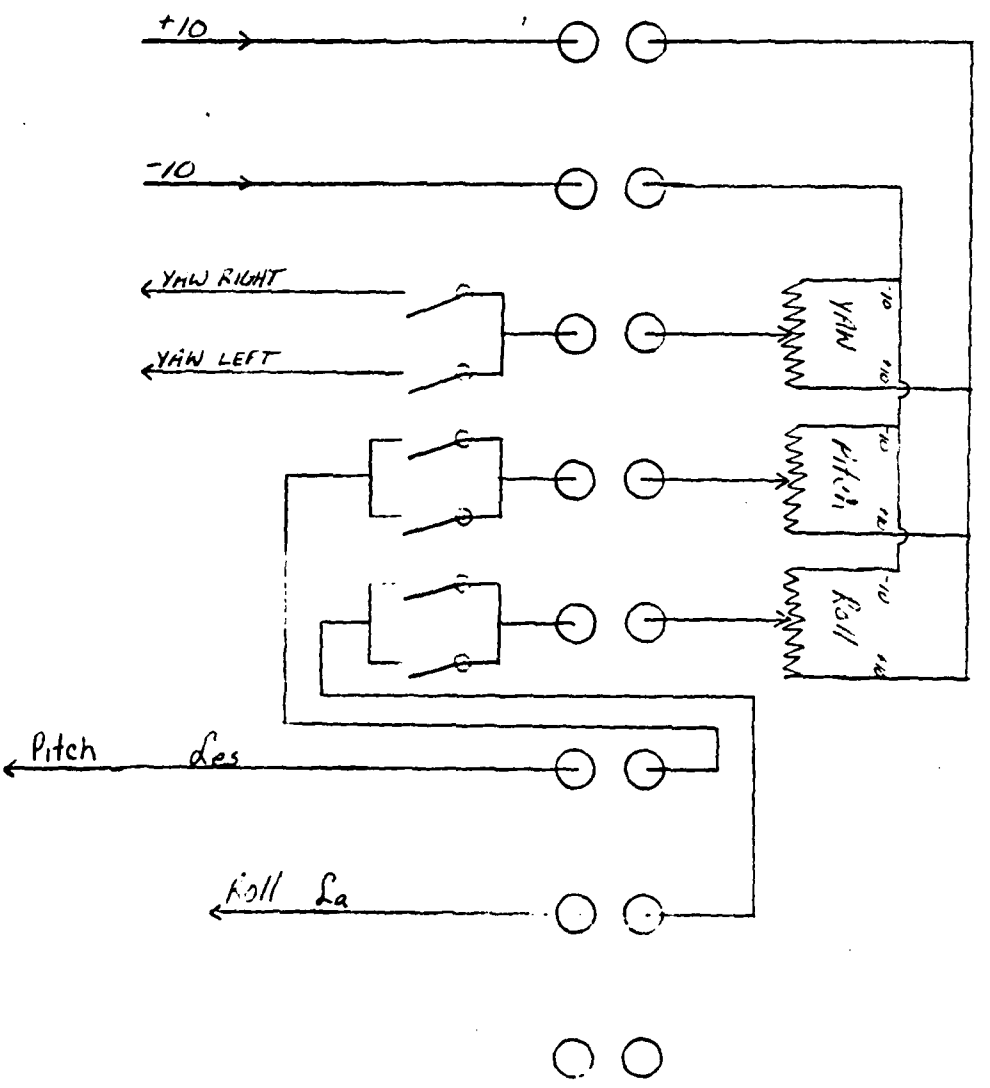


Fig A-4. Control Stick Wiring Diagram

The calculation for P_{SS}/F_{AS} required several factors. The first value of .012 lb/deg was obtained from the stick calibration. The 7.83 deg/in was derived from the amount of stick radius moved per degree. The 2.16 v/in was obtained from Dammarell's calibration of the stick (Ref 11). Φ was measured from the output of integrator 34.

$$\frac{\text{deg}}{.012\ \text{lb}} \quad \frac{1\ \text{in}}{7.83\ \text{deg}} \quad \frac{2.16\ \text{v}}{\text{in}} \quad \frac{.95\ \text{deg/sec}}{\text{v}} = 21.83\ \frac{\text{deg/sec}}{\text{lb}}$$

$$P_{SS}/F_{AS} = 21.83\ (\text{deg/sec})/\text{lb}$$

The other measured values of P_{SS}/F_{AS} were calculated in a similar manner.

APPENDIX B
SCHEMATIC DIAGRAMS

The EAI 2000 analog computer was used for all experiments. The pitch and roll equations, as well as the performance measures, were all programmed on one board. The descriptions are printed with the permission of Electronic Associates Incorporated of New Jersey (permission statement included). Before detailing each diagram, each individual component is described below. The schematic diagrams show the circuitry used to implement this experiment. The simulation was accomplished by the computer technician.

Oscilloscope Images

Figure B-1 is the circuit diagram for the generation of command, subject response and external trigger for the oscilloscope. Integrator zero produces the sawtooth signal (labeled X); it is connected directly to the external trigger of the oscilloscope. Signal X is also used to generate the W. The output of summer 52 is the W signal. Switch 3 allows either the subject pitch (amp 71) or roll (integrator 34) to control the W on the scope. Switch 7 allows either the sum of sine waves (switch 67) or the random step (switch 25) to control the command bar on the scope. Amplifiers 42, 45, 46, 47, and 51 make up the slopes for the W signal.

Pitch and Roll Equations

Figures B-2 and B-3 show the circuitry for the pitch and roll simulations. Since it would be too cumbersome to explain each connection in the drawings, the equations for each signal are shown as the output for the amplifiers. For continuity, summer 71 (Fig B-2) and integrator 34 (Fig B-3) are shown in Fig B-1.

Sum of Sine Waves

Figure B-4 illustrates the sum of sine waves input signal. The signal is made up of six different sine waves. The output of summer 67 is the total sum. Each sine wave has a peak voltage of one volt, therefore, the maximum peak signal is six volts. The output of track/store amp 6 is used for the generation of the random step function (Fig B-5). Switch 67 is shown in Fig B-1 for continuity.

Random Step

The random step function generator is shown in Fig B-5. Comparator 31 compares the sum of sine waves signal to one volt. The comparator inhibits signal changes of less than one volt and passes greater than one volt. Counter 26 counts down every 1.5 seconds. The track/store circuitry (6 and 26) ensure a pulse change at least every two changes of flip flop 11. Therefore, the time between step changes is at least three seconds. Switch 25 is shown in Fig B-1 for continuity.

Evaluation Methods

Figure B-6 is the circuitry used to evaluate the RMS error and time on target. The output of summer 126 is the error signal and it is used by both the RMS error and time on target hardware. Comparator 35 compares the error with the margin of error. In pitch (pot 37) the margin of error is one division on the scope face. The margin of error for roll is 4 degrees (pot 33) in slope between command and subject response. The comparator inhibits signals greater than the margin of error. The increment for time on target is 0.1 volts/second. The time on target value is stored in analog to digital port number 3.

The error is fed as an RMS value into analog to digital port number 1. The circuit located in the lower left ensures an RMS error value is stored once each second.

The circuit in the lower right acts as a timed switch. It is activated when the test begins, runs for 91 seconds, then shuts off the input signal. The 91-second shutoff is needed to ensure that all the time on target and RMS data values have entered their respective analog to digital ports. The analog to digital ports keep track of the voltages and allows the digital program (Appendix C) to read and store their values.

Switching Diagram

Figure B-7 shows the switching wiring necessary for switching between the input signals and the roll and pitch

[illegible] Parkway, West Long Branch N.J. 07764 (201) 229-1100

August 9, 1982

Capt. Nathan Krys
AFIT/EN
Box 4237
Wright Patterson AFB
Ohio 45433

Dear Capt. Krys:

This letter is authorizing your request to use parts of Chapter 4 from our EAI 2000 Analog Reference Book for your thesis.

If you have any additional requests, please do not hesitate to call me.

Sincerely yours,

William Kaplan

William Kaplan
Product Manager

WK/ejb

4.2 COEFFICIENT UNIT

FUNCTION:

Continuous multiplication of an analog variable times a constant coefficient.

DESIGNATIONS:

DCA Digitally Controlled Attenuator or Digitally Set Coefficient Unit
POT Manually Set Coefficient Unit

SYMBOL:

As shown in Figure 4.1

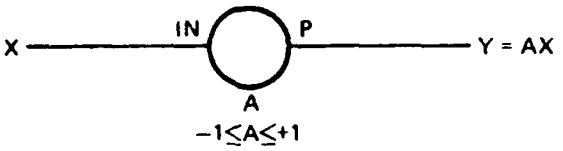


Figure 4.1 Coefficient Unit: Typical Programming Symbol

4.3 SUMMER

FUNCTION:

Continuous summation of several analog variables.

OPTIONS:

As an optional feature, the 4-input and the 7-input Summer can be equipped with a variable limiter. The limiter is described in Paragraph 4.14. Note that earlier versions of the EAI 2000 are not equipped with a 4-input Summer and its optional Limiter.

DESIGNATIONS:

SUM, Σ

SYMBOL:

As shown in Figure 4.4

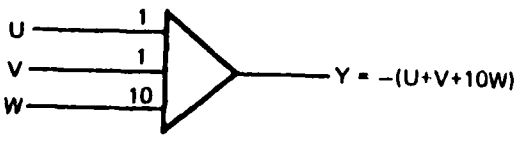


Figure 4.4 Summer: Typical Programming Symbol

4.4 INTEGRATOR

FUNCTION:

Continuous integration, with respect to time, of an analog variable.

OPTIONS:

As an optional feature, the Integrator can be equipped with a variable limiter. The limiter is described in Paragraph 4.14.

SYMBOL:

As shown in Figure 4.6.

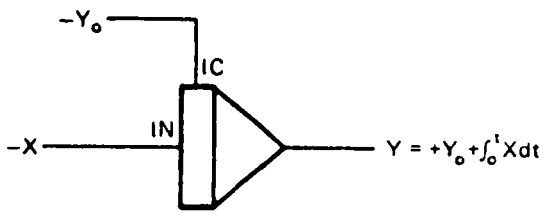


Figure 4.6 Integrator: Typical Programming Symbol

4.5 MULTIPLIER

FUNCTION:

Continuous multiplication of two analog variables.

DESIGNATIONS:

MUL

SYMBOL:

As shown in Figure 4.9.

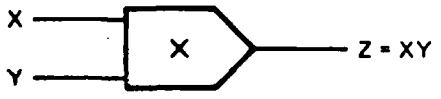


Figure 4.9 Multiplier: Typical Programming Symbol

4.7 SQUARE ROOT GENERATOR

FUNCTION:

Generate the Square Root of an analog variable.

DESIGNATION: $\sqrt{\ }$

SYMBOL:

As shown in Figure 4.13.

Figure 4.13 Square Root Generator: Programming Symbol

4.8 TRACK-STORE UNIT

FUNCTION:

Store an analog value.

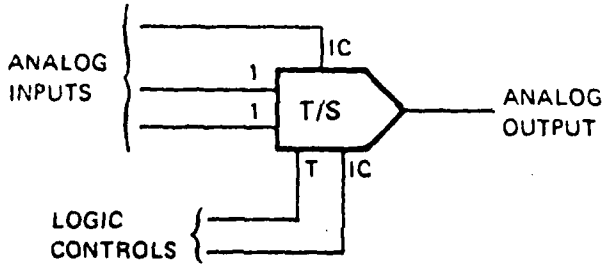
OPTIONS:

As an optional feature, later versions of the TS/Σ tray (Model Number 0.72.0051-1) contain a Limiter that is associated with the Track-Store Unit. The Limiter is described in Paragraph 4.14. The earlier versions (Model Number 0.72.0049) TS/Σ tray does not have this option.

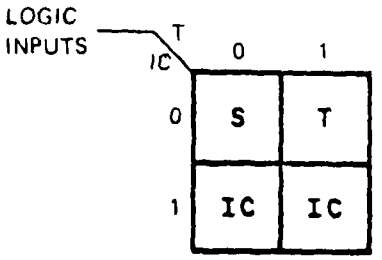
DESIGNATIONS: T/S

SYMBOL:

As shown in Figure 4.16.



a. Symbol



b. Logic Mode Control

Figure 4.16 Track-Store Unit: Programming Symbol

4.9 SELECTOR SWITCH

FUNCTION:

Analog Signal Switching

DESIGNATION: SW

SYMBOL:

As shown in Figure 4.21.

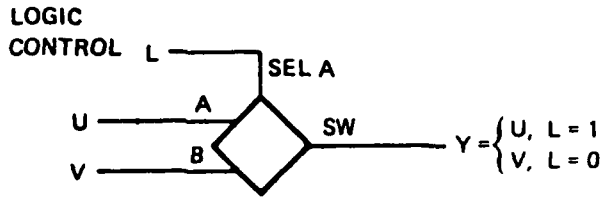


Figure 4.21 Selector Switch: Typical Programming Symbol

4.10 SINE GENERATOR

FUNCTION:

Generate the Sine of an analog variable.

DESIGNATION: SIN

SYMBOL:

As shown in Figure 4.23.

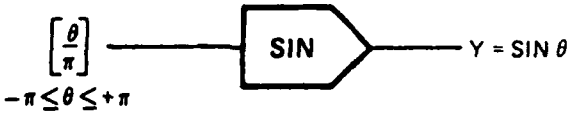


Figure 4.23 Sine Generator: Typical Programming Symbol

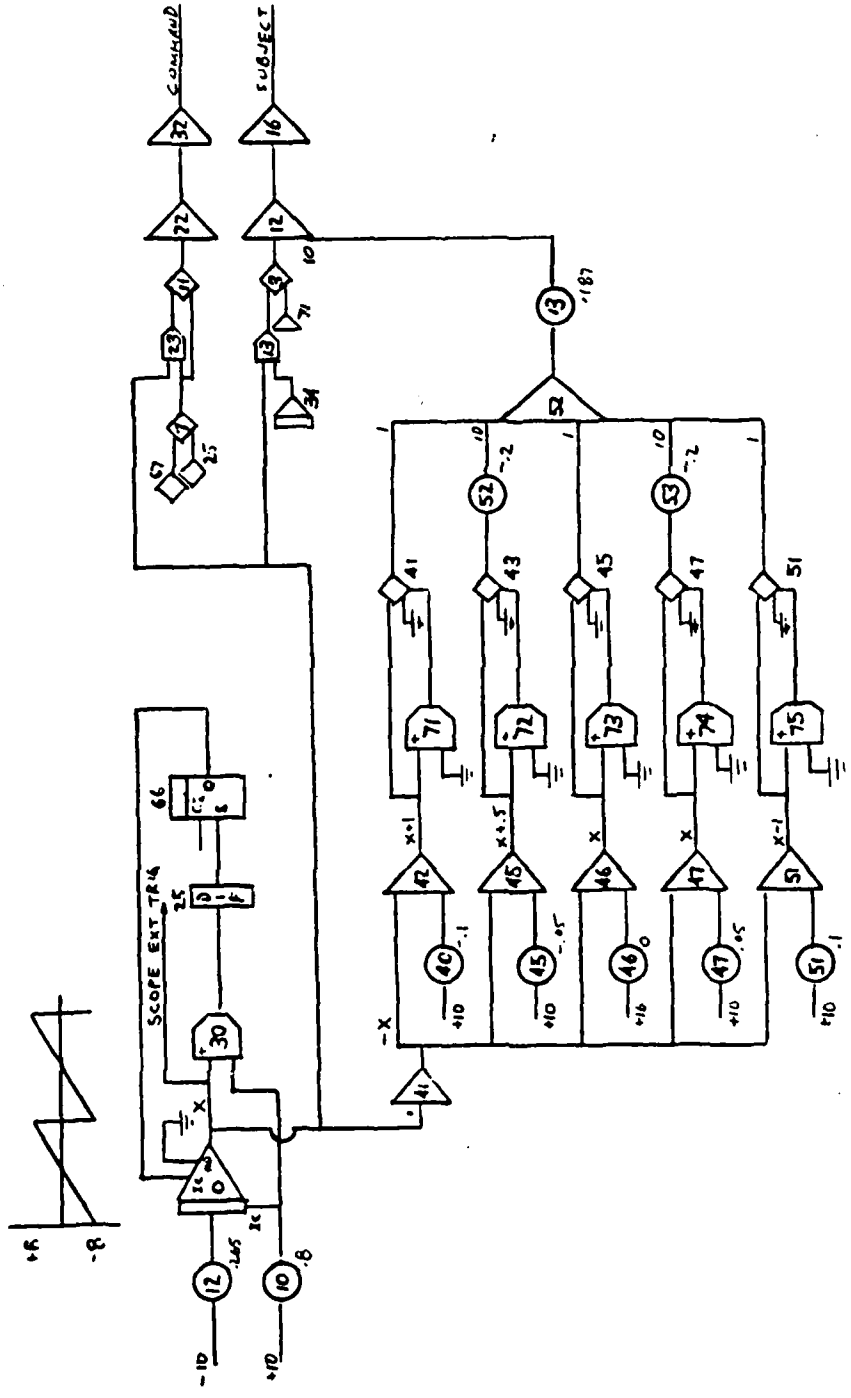


FIGURE 1-1 GENERATION OF COMMAND AND W SIGNALS

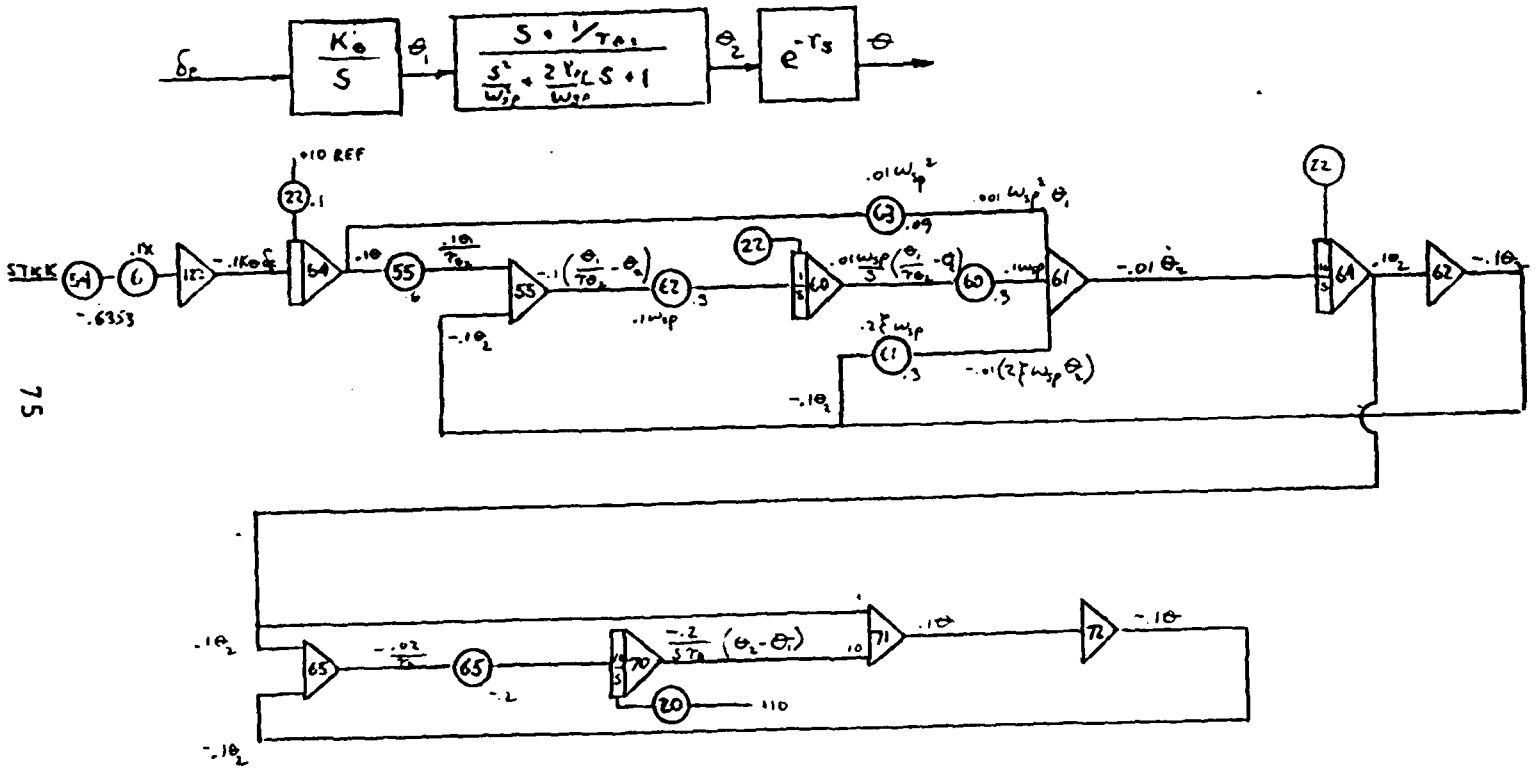


FIGURE B-2 PITCH SIMULATION

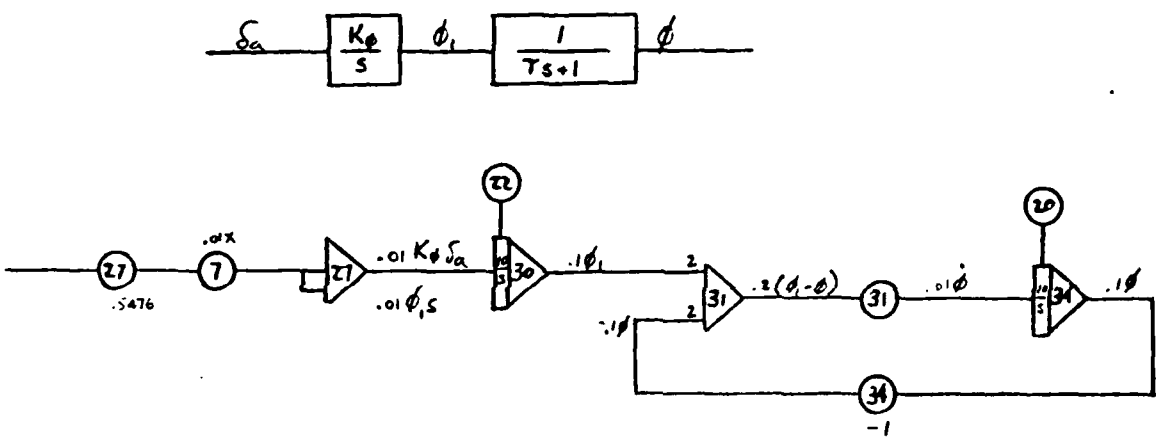


FIGURE B-3 ROLL SIMULATION

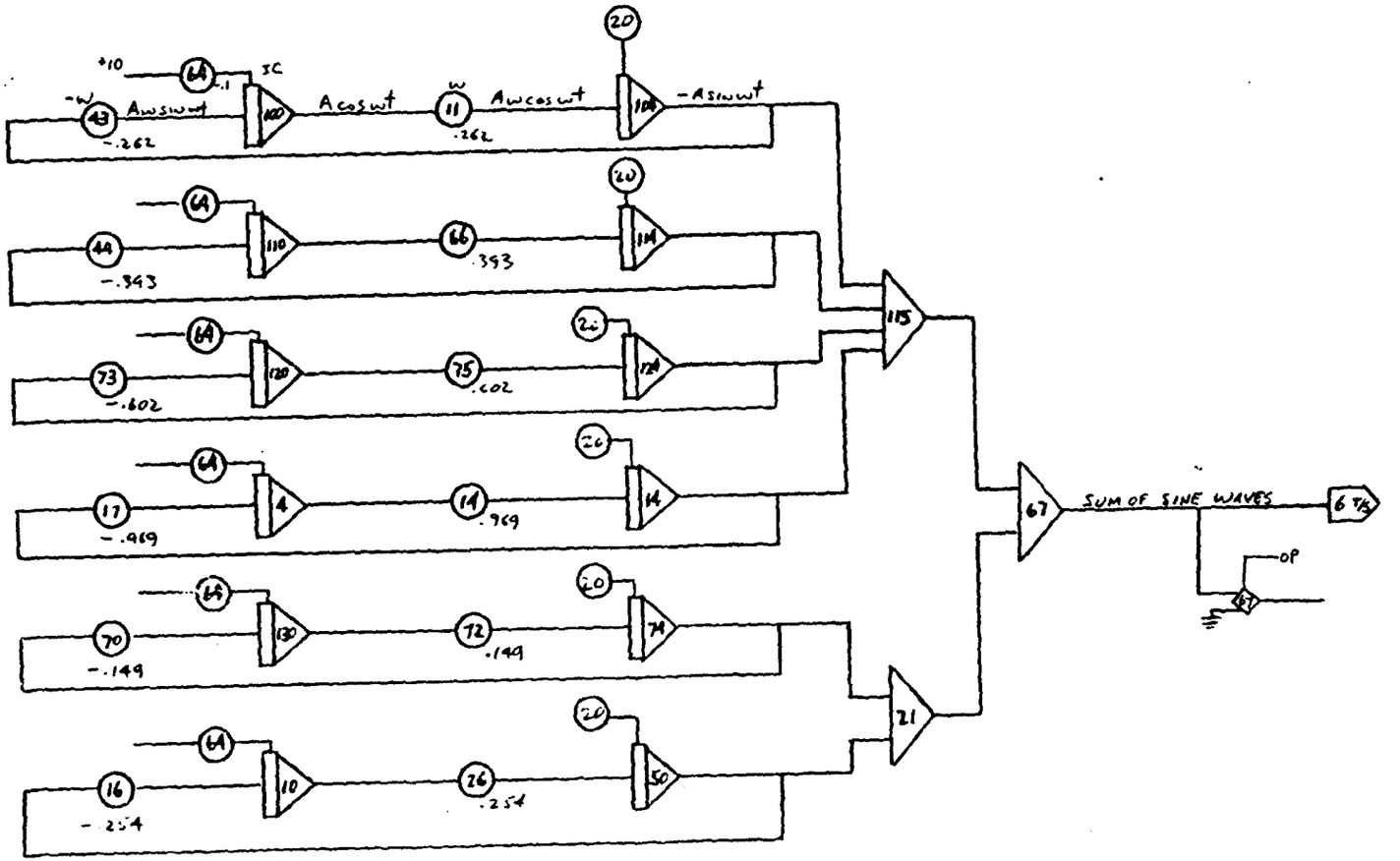


FIGURE B-4 GENERATION OF SUM OF SINE WAVES

STEP Function.

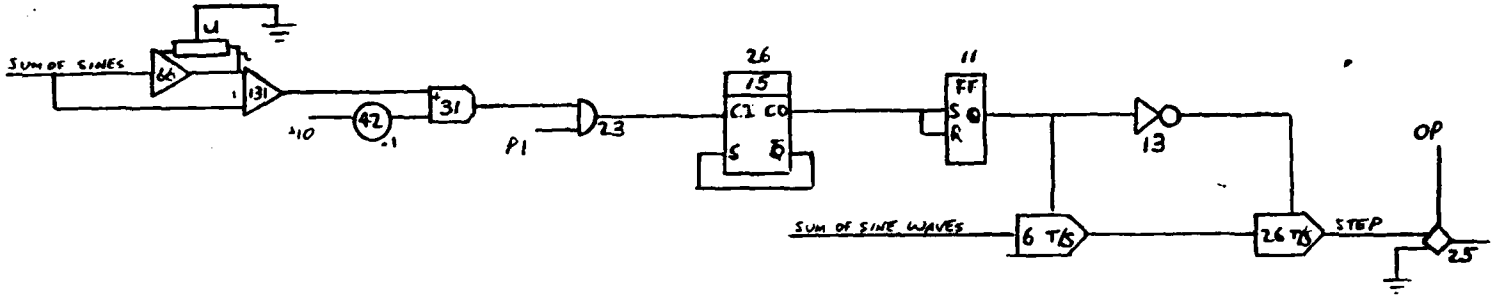


FIGURE B-5 GENERATION OF RANDOM STEP FUNCTION

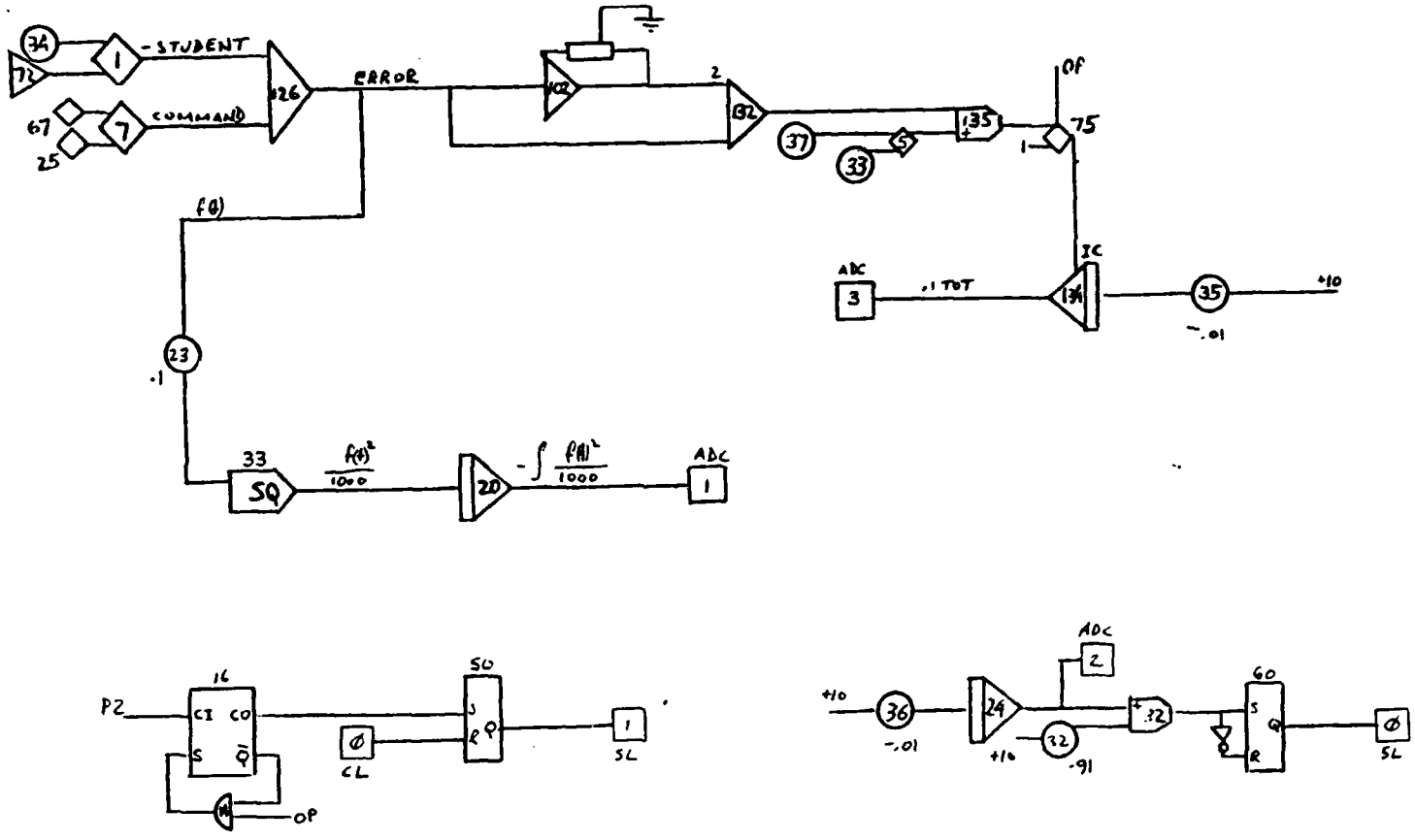


FIGURE B-6 EVALUATION CIRCUITRY

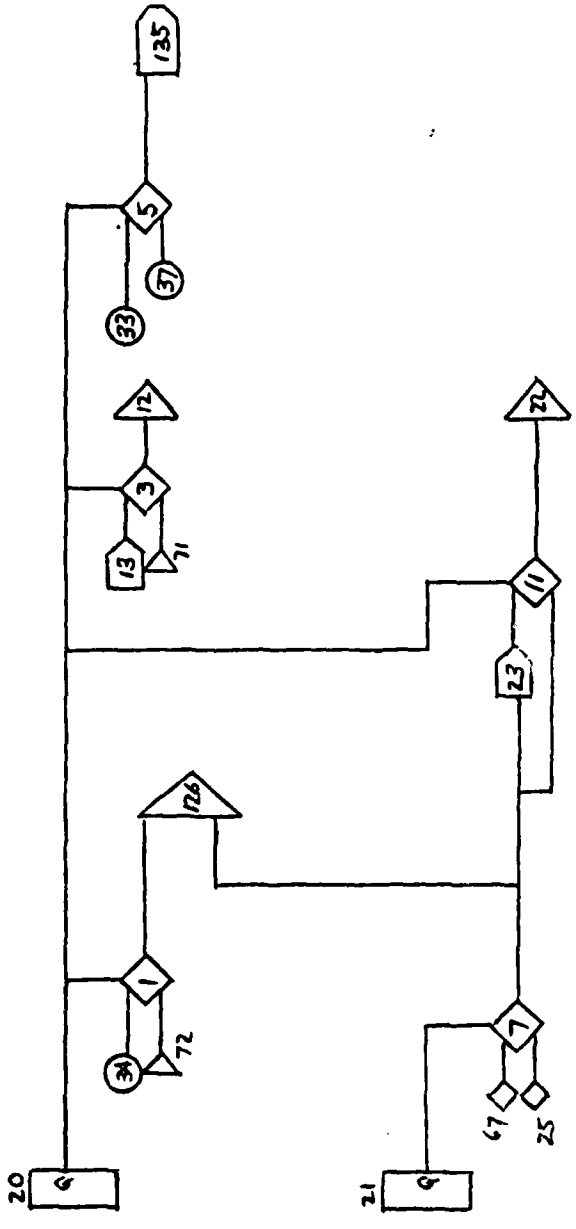


FIGURE B-7 SWITCHING INTER CONNECTIONS

APPENDIX C

PROGRAM USED TO INITIALIZE THE EAI 2000 ANALOG COMPUTER

The purpose of this program is to initialize the system on the EAI 2000 by setting specific values for all potentiometers, integrators and counters. It also changes potentiometers to show the change in variables for the different runs involved.

After the program begins the run, it monitors flip flops 50 and 60 (Appendix B, Fig B-6). If flip flop 60 is set high, the run has gone 91 seconds and the program stops the run. If 50 is high, the program samples and stores the values of analog to digital converters 1, 2, and 3 stores the values in an array and resets flip flop 50.

When the run has stopped (flip flop 60 - high), the program calculates the RMS mean error and time on target, then prints out the values.

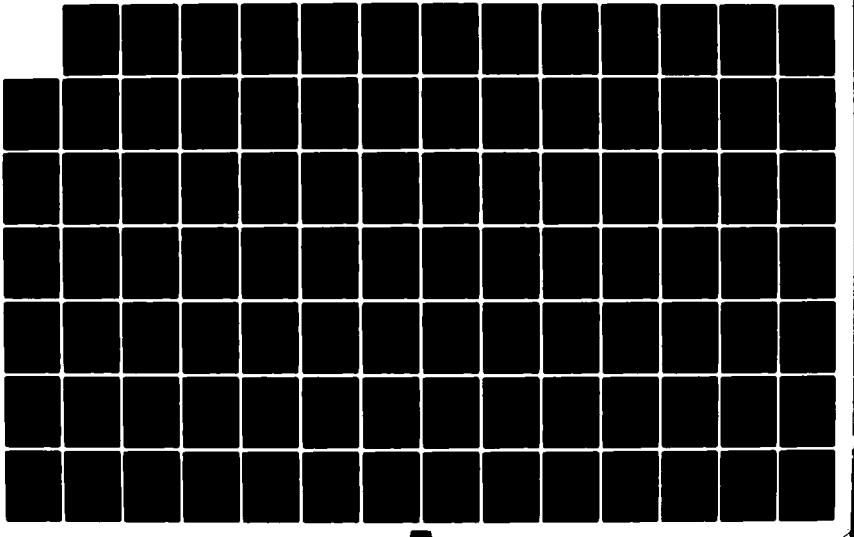
```
      PROGRAM FLY
C
C  THIS PROGRAM WAS DEVELOPED FOR THE MAN-IN-THE-LOOP FLIGHT TESTING
C  PROJECT DONE BY MIKE DAMMARELL DURING THE SUMMER OF 1982.  IT
C  FIRST SETS ALL POTS,INTEGRATERS AND COUNTERS TO VALUES SHOWN IN THE
C  DIAGRAMS AND PERMITS THE OPERATOR TO DO A STATIC CHECK.  IT THEN
C  ALLOWS THE OPERATOR TO RUN TESTS FOR PITCH OR ROLL, USING THE SUM
C  OF SINE WAVES OR THE STEP FUNCTION AND DIFFERENT VARIABLES FOR
C  EACH RUN.
C
C
      DIMENSION RMS(91),TOT(91),A20(91),A24(91)
      INTEGER I,J,FUNCT,AGRP
      INTEGER*2 I0,I1,I3
      REAL X,OMEGA,ZETA,TAUDEL,TAUTHE,TAUPHI,KTHETA,KPHI,
     *RMS,TOT,A20,A24,RMSMN
      LOGICAL AFFL,RSLS
      COMMON/ANALIO/NCL,DAC(64), NSL,ADC(32)
      DATA I0/0/,I1/1/,I3/3/
C
      WRITE(105,10)
   10 FORMAT(' WHICH CONSOLE ARE YOU ON?')
      READ(105,80) ICON
      CALL SELCON(ICON)
      CALL AJOG
C
C     SET COUNTER VALUES
C
      CALL SWCTRI(0,75)
      CALL SWCTRI(2,10)
      CALL SWCTRI(1,100)
C*****************************************************************************
C
C     SET POT VALUES
C
      CALL SWDAC(41,.1)
      CALL SWDAC(42,.1)
      CALL SWDAC(43,.1)
      CALL SWDAC(27,.47)
      CALL SWDAC(21,1.)
```

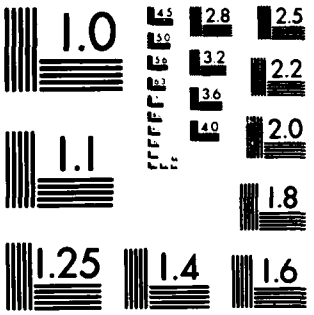
```
      CALL WRTDCA(54,-.6358)
      CALL WRTDCA(62,.16)
      CALL WRTDCA(69,.0125)
      CALL WRTDCA(71,-.9)
      CALL WRTDCA(12,.265)
      CALL WRTDCA(10,.9)
      CALL WRTDCA(13,.187)
      CALL WRTDCA(40,-.1)
      CALL WRTDCA(45,-.05)
      CALL WRTDCA(46,.0)
      CALL WRTDCA(47,.05)
      CALL WRTDCA(51,.1)
      CALL WRTDCA(52,-.2)
      CALL WRTDCA(53,-.2)
      CALL WRTDCA(34,-1.)
      CALL WRTDCA(64,-.1)
      CALL WRTDCA(20,-.1)
      CALL WRTDCA(22,.1)
      CALL WRTDCA(43,-.262)
      CALL WRTDCA(11,.262)
      CALL WRTDCA(44,-.393)
      CALL WRTDCA(66,.393)
      CALL WRTDCA(73,-.602)
      CALL WRTDCA(75,.602)
      CALL WRTDCA(17,-.969)
      CALL WRTDCA(14,.969)
      CALL WRTDCA(70,-.149)
      CALL WRTDCA(72,.149)
      CALL WRTDCA(16,-.254)
      CALL WRTDCA(24,.254)
      CALL WRTDCA(37,.04)
      CALL WRTDCA(38,.111)
      CALL WRTDCA(39,-.01)
      CALL WRTDCA(67,.915)
      CALL WRTDCA(42,.1)
      CALL WRTDCA(41,.1)
C     ********************************************************************

C     SET INTEGRATION TIME SCALE
C
```

AD-A124 699 EXPERIMENTAL TESTING OF FLYING QUALITIES THEORIES(U) 2/3
AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL
OF ENGINEERING N H KRYS DEC 82 AFIT/GE/EE/82D-43

UNCLASSIFIED F/G 14/2 NL





```
        CALL GWITSR(0,1000.)
        CALL GWITSR(54,10.)
        CALL GWITSR(64,100.)
        CALL GWITSR(70,1.)
        CALL GWITSR(50,10.)
        CALL GWITSR(34,10.)
        CALL GWITSR(150,10.)
        CALL GWITSR(74,10.)
        CALL GWITSR(50,10.)
        CALL GWITSR(10,10.)
        CALL GWITSR(134,1.)
        CALL GWITSR(20,1.)
        CALL GWITSR(100,1.)
        CALL GWITSR(104,1.)
        CALL GWITSR(110,1.)
        CALL GWITSR(114,1.)
        CALL GWITSR(120,1.)
        CALL GWITSR(124,1.)
        CALL GWITSR(4,1.)
        CALL GWITSR(14,1.)
        CALL GWITSR(24,1.)
C*****************************************************************
C
        CALL GSST
        WRITE(105,20)
 20     FORMAT(' DO STATIC AND RETURN TO CONTINUE')
        READ(105,30) IX
 30     FORMAT(1X,39A2)
C     MUST HAVE GSIC BEFORE GSRUN TO HAVE SINE WAVES START CORRECTLY
        CALL GSIC
        CALL GSRUN
        WRITE(105,40)
C     MAKE SURE SOS WAVES AND STEP FUNCTION WORKIN,
 40     FORMAT(' CHECK SINE (A67), STEP (A26), RETURN TO CONTINUE')
        READ(105,50) IX
C     TO GET RID OF OVERLOADS CAUSED BY INTEGRATION LAG
        WRITE(105,60)
 60     FORMAT(' PULL/PUSH LOGIC TO SET ITSR'S - THEN TO CONT.')
        CALL GSST(1)
C*****************************************************************
```

```
C
C     CHOOSE TO TEST ROLL OR PITCH
C
 60    WRITE(105,70)
 70    FORMAT(' 0 FOR PITCH, 1 FOR ROLL')
       READ(105,80) J
 80    FORMAT(I1)
       IF(J .EQ. 0)CALL QWFFL(20,.FALSE.)
       IF(J .EQ. 0)RORP=0
       IF(J .EQ. 1)CALL QWFFL(20,.TRUE.)
       IF(J .EQ. 1)RORP=1
C*****************************************************************
C
C     CHOOSE SUM OF SINE WAVES OR STEP FUNCTION
C
C
 90    WRITE(105,100)
 100   FORMAT(' 0 FOR STEP, 1 FOR SINE')
       READ(105,80) J
       IF(J .EQ. 0)CALL QWFFL(21,.FALSE.)
       IF(J .EQ. 0)FUNCT=0
       IF(J .EQ. 1)CALL QWFFL(21,.TRUE.)
       IF(J .EQ. 1)FUNCT=1
C*****************************************************************
C
 110   IF(RORP .EQ. 1) GO TO 180
C
C     SELECT VARIABLES FOR PITCH TEST AND SETS APPROPRIATE POTS
C
       WRITE(105,120)
 120   FORMAT('0OMEGA')
       READ(105,130)X
 130   FORMAT(F6.3)
       OMEGA=X
       CALL SWPOT3(-1,.1*X)
       CALL WBUCAR(15,(.1*X)**2)
       CALL SWPOT2(-0,.1*)
       WRITE(
 140   FORMAT(' ZETA')
       READ(105,130)Y
```

```
161          ZETA=Y
162          CALL GWDCAR(61,.2*X*Y)
163          WRITE(105,150)
164   150    FORMAT(' TAUTHETA')
165          READ(105,130) X
166          TAUTHE=X
167          CALL GWDCAR(55,1./X)
168          WRITE(105,160)
169   160    FORMAT(' TAUDELTA')
170          READ(105,130) X
171          TAUDEL=X
172          CALL GWDCAR(65,-.02/X)
173          GO TO 210
174   C*************************************************************************
175   C
176   C     SELECT VARIABLES TO DO ROLL TEST AND SET APPROPRIATE POTS
177   C
178    180   WRITE(105,190)
179    190   FORMAT(' TAUPHI')
180          READ(105,130) X
181          TAUPHI=X
182          CALL GWDCAR(31,.05/X)
183   C*************************************************************************
184   C
185    210   WRITE(105,220)
186    220   FORMAT(' RETURN TO START FLYING')
187          READ(105,30) IX
188          CALL GWFFL(50,.FALSE.)
189          CALL GWFFL(61,.FALSE.)
190          I=1
191          CALL GSOP
192   C
193   C
194    230   CONTINUE
195   C     CHECK TO SEE IF TIME IS UP
196          IF(RLS(10)) GO TO 240
197   C     IF NOT TIME TO SAMPLE DO THIS
198   C
199   C     SAMPLE THE VALUES
200          A24(I)=ABS(ADC(2)*10.)
```

```
      A20(I)=ABS(ADC(1)*1000.)
      TOT(I)=ABS(ADC(3)*10.)
C     LOOP UNTIL FF50 GETS SET FALSE
 235  CALL WCLS(I3,I0)
      IF(RSLS(I1))GO TO 235
      I=I+1
C     STAY WITHIN ARRAY
      IF(I .GE. 92) I=91
      GOTO 230
C***********************************************************************
C
C     90 SECONDS UP, END OF RUN
C
 240  CALL OSHOLD
C     BE SURE TO GET LAST SAMPLE
      A24(I)=ABS(ADC(2)*10.)
      A20(I)=ABS(ADC(1)*1000.)
      TOT(I)=ABS(ADC(3)*10.)
      CALL OSIC
C     MAKE SURE VALUES WERE SAMPLED
      WRITE(108,241) A20,A24
 241  FORMAT('1',6(3X,F7.2))
      WRITE(108,*) I
C     CALCULATE K FOR ROLL AND PITCH
      KPHI=200.*(COE(007))
      KTHETA=20.*(COE(006))
C     COMPLETE RMS CALCULATIONS
      DO 250 M=1,91
 250    RMS(M)=SQRT(A25(M)/A24(M))
C     FIND MEAN VALUE FOR RMS
      RMSMN=0
      DO 255 K=10,90
 255    RMSMN=RMSMN+RMS(K)
      RMSMN=RMSMN/81.
C
C***********************************************************************
C
C     PRINT OUTPUT
C
      WRITE(108,260)
```

```
241   240   FORMAT('1   OMEGA   ZETA   TAUTHETA   TAUDELTA   TAUPHI',
242        **   KTHETA   KPHI')
243         WRITE(108,270)OMEGA,ZETA,TAUTHE,TAUDEL,TAUPHI,KTHETA,KPHI
244   270   FORMAT(' ',3(3X,F5.2),2(6X,F5.2),2X,F6.2,3X,F6.2)
245         IF(RORP .EQ. 0) WRITE(108,280)
246   280   FORMAT('0PITCH')
247         IF(RORP .EQ. 1) WRITE(108,290)
248   290   FORMAT('0ROLL')
249         IF(FUNCT .EQ. 0) WRITE(108,300)
250   300   FORMAT(' STEP FUNCTION')
251         IF(FUNCT .EQ. 1) WRITE(108,310)
252   310   FORMAT(' SUM OF SINE WAVES FUNCTION')
253         WRITE(108,320)
254   320   FORMAT('0',21X,'RMS VALUE OF ERROR')
255         WRITE(108,330) (RMS(I),I=1,90)
256   330   FORMAT('+',/,6(3X,F7.2))
257         WRITE(108,331) RMSMN
258   331   FORMAT('0MEAN OF RMS=',F5.2)
259         WRITE(108,340)
260   340   FORMAT ('0',21X,'TIME ON TARGET (SECS)')
261         WRITE(108,330) (TOT(I),I=1,90)
262         END FILE 108
263   C*****************************************************************
264   C
265   C     DO YOU WANT TO CONTINUE AND MAKE CHANGES
266   C
267         WRITE(105,350)
268   350   FORMAT('0THIS RUN IS DONE,STOP THE STRIP CHART.',/,
269        **' IF YOU WISH TO STOP FOR THE DAY TYPE 1, ELSE TYPE 0')
270         READ(105,60) J
271         IF(J.EQ.1) GO TO 390
272         WRITE(105,360)
273   360   FORMAT(' DO YOU WISH TO MAKE CHANGES? 0=NO, 1=YES')
274         READ(105,60) J
275         IF(J.EQ.1) GO TO 370
276         GO TO 910
277   370   WRITE(105,380)
278   380   FORMAT('0',/,
279        **' 1-CHANGE ZETA,OMEGA ETC,',/,
280        **' 2-CHANGE PITCH OR ROLL',/,
```

```
  281         ** 3-CHANGE SINE OR STEP')
  282          READ(105,80) J
  283          GO TO(110,60,90),J
  284    350   STOP
  285          END
  286   C*****************************************************************************
  287   C
  288          SUBROUTINE CNTMSG(IBUF,NB)
  289          INTEGER*2  IBUF(20)
  290          DATA NLP/0/
  291          NLP=NLP+1
  292          NW=(NB+1)/2
  293          WRITE(105,1100) (IBUF(J),J=1,NW)
  294   1100   FORMAT(1X,39A2)
  295          IF(NLP .LT. 20)RETURN
  296          WRITE(105,1200)
  297   1200   FORMAT(' RETURN TO CONTINUE')
  298          READ(105,1100) IX
  299          ENTRY DONMSG
  300          NLP=0
  301          RETURN
  302          END
TOTAL RECORDS WRITTEN =    303/      28
EXIT
```

APPENDIX D

PILOT EXPERIENCE AND TESTING SCHEDULE

Pilot	Aircraft	Hours Flown
DS	T-38	1400
	F-16	350
MK	T-33	800
	C-47,B-25	1000
MM	C-141	2200
RL	F-111	1800
SF	F-4	500

Pilot	Test Start #/Sum of Sines	Test Start #/Step Function
DS	4/2 Aug	1/9 Aug
MK	7/3 Aug	10/12 Aug
MM	10/10 Aug	1/9 Aug
RL	1/16 Aug	4/10 Aug
SF	1/29 Aug	7/5 Aug

APPENDIX E

PILOT COMMENT DATA

This appendix contains all the pilot comments and ratings given during the test runs. Most of the comments are one-word descriptions, and each thought is separated by a comma. All τ's refer to τ_R.

Sum of Sine Waves

Pilot: DS
Date: 2 Aug

Test 1 τ = .45 K = 49.38 PR 4
too sluggish, I can keep up with the command signal, but the stick is too sluggish

Test 2 τ = .45 K = 123.42 PR 3
better, less sluggish, some lead required

Test 3 τ = .45 K = 133.33 PR 2.5
fast response, felt like I have weights on the wings, slight PIO, overshot

Test 4 τ = .25 K = 400 PR 2
pretty good, responded the right amount for stick movement, responded quickly

Test 5 τ = .25 K = 160 PR 2.5
not a whole lot of difference, not as responsive to stick inputs

Test 6 τ = .25 K = 320 PR 2
felt like Test 4, no difference, just fine

Test 7 τ = .8 K = 15.63 PR 7.5
sluggish stick, couldn't keep up with command signal

Test 8 τ = .8 K = 39.1 PR 7
some improvement, roll would keep up with command, some PIO (overshoot)

Test 9 τ = .8 K = 225 PR 4

fairly quick response, I didn't like it, small stick input made large change in W

Test 10 τ = .15 K = 1111.1 PR 4
required a lot of effort not to overcontrol, fast response

Test 11 τ = .15 K = 444.44 PR 3
this is better, not as much effort (required to control), fast response

Test 12 τ = .15 K = 833.33 PR 2
fast response, no problem with control

Test 13 τ = .1 K = 1000 PR 1.5
liked it, fast response, no PIO (overshoot)

No Test 14, after several runs, DS could not improve on Test 13.

Pilot: MK
Date: 3 Aug

Test 1 τ = .45 K = 49.38 PR 6
response too sluggish, no overshoot

Test 2 τ = .45 K = 123.42 PR 4.5
much better, response to stick is still sluggish

Test 3 τ = .45 K = 388.88 PR 5
response still sluggish, overshoots

Test 4 τ = .25 K = 400 PR 3.5
better, responds quicker and small overshoot

Test 5 τ = .25 K = 160 PR 4.5
too sluggish, overshoot okay, very slow

Test 6 τ = .25 K = 800 PR 3
sluggish, slight overshoot, not enough damping

Test 7 τ = .8 K = 15.63 PR 7.5
not responsive, doesn't respond quick enough, overshoots, plant is no good

Test 8 τ = .8 K = 39.1 PR 6.5
not quite so bad, responds too slowly, still overshoots

Test 9 τ = .8 K = 225
much better adequate response, still too much inertia and overshoot

Test 10 τ = .15 K = 1111.1 PR 3.5
easier to track, too much inertia and slight overshoot

Test 11 τ = .15 K = 444.44 PR 3
best one yet, responded quick, less overshoot

Test 12 τ = .15 K = 900 PR 2
very responsive, no overshoots,no complaints, easy to fly

Test 13 τ = .1 K = 1000 PR 2.5
not responsive, damping okay, no overshoot

Test 14 τ = .1 K = 2000 PR 2.5
I like this, pretty responsive, little overshoot, good damping

Pilot: MM
Date: 10 Aug

Test 1 τ = .45 K = 49.38 PR 6
terrible, sluggish, stick seemed almost dead, it was slow when I wanted to move in a different direction, no good

Test 2 τ = .45 K = 49.38 PR 4
better, faster reaction to stick input, smoother not as sluggish as before, stick more sensitive, stick more proportional (further I move the stick--faster the response)

Test 3 τ = .45 K = 277.77 PR 2
better, went right where I wanted it to go, just about right

Test 4 τ = .25 K = 400 PR 4
a little slow, otherwise pretty good

Test 5 τ = .25 K = 160 PR 5.5
seemed even more slow, less sensitive, (I was) always behind what I wanted to do

Test 6 τ = .25 K = 600 PR 1.5
sensitivity good, reaction time on stick response good, proportional stick, overall pretty good, (I) liked it

Test 7 τ = .8 K = 15.63 PR 8
terrible, slow, very sluggish, bad overall

Test 8 τ = .8 K = 39.1 PR 5.5
little better, not as sluggish, too much inertia, overshoot

Test 9 τ = .8 K = 143.75 PR 3
sensitivity good, less inertia, fast reaction time, therefore had to compensate for overshoot, overall not bad--fairly good

Test 10 τ = .15 K = 1111.1 PR 4
good and smooth, a little fast at times, not bad overall,

needed more control (since it) wasn't sensitive enough

Test 11 τ = .15 K = 444.44 PR 2.5
better overall, sensitivity better, good and smooth, easier flying task

Test 12 τ = .15 K = 833.33 PR 2
better, improved sensitivity, everything else is the same, it reacts better

Test 13 τ = .1 K = 1000 PR 4
fair, smooth, sensitivity (reaction of stick) was stair stepped, no extra momentum, W stopped when stick movement stopped

Test 14 τ = .1 K = 1250 PR 1
pretty good, smooth, sensitivity easy to control, just about right proportional movement of stick, no lag time, response was instantaneous

Pilot: RL
Date: 16 Aug

Test 1 τ = .45 K = 49.38 PR 6
not very good, initial response slow, roll rate slow, overshoot, used maximum stick deflection to arrest roll rate

Test 2 τ = .45 K = 123.42 PR 5
better, primarily response is more predictable in arresting roll rate, initial response about the same

Test 3 τ = .45 K = 277.77 PR 4
seemed roll rate was non-linear before, this was more predictable, roll in and roll out no change, command got away from me before but I had better response with this run, warrants improvement

Test 4 τ = .25 K = 400 PR 4
didn't seem very predictable, roll in response didn't have a good feel, needed compensation

Test 5 τ = .25 K = 160 PR 4
slower, more predictable, easier to control, actually better in accomplishing task

Test 6 τ = .25 K = 600 PR 3
mildly unpleasant deficiencies, occasional small PIO (overshoot) very minor though, minimum desired performance better

Test 7 τ = .8 K = 15.63 PR 7
not very good, bang-bang system, definitely requires improvement, can't perform task, slow system, need max

deflection, control no problem

Test 8 τ = .8 K = 39.1 PR 7
better but not by much, quicker, roll out still needs lead time, task still difficult

Test 9 τ = .8 K = 156.25 PR 6
very objectionable, extensive compensation, must anticipate an input that can't be anticipated, tendency to overshoot

Test 10 τ = .15 K = 1111.1 PR 5
needs improvement, still need pilot compensation, real high gain, less overall error but when there is an error (I) miss it by a lot

Test 11 τ = .15 K = 444.44 PR 6
need something in between, poor initial response--all gone, there's more overshoot

Test 12 τ = .15 K = 833.33 PR 3
best overall, good response for large amplitude corrections

Test 13 τ = .1 K = 1000 PR 4
not all that bad, roll out response not predictable--a little too quick, for large correction some overshoot

Test 14 τ = .1 K = 1500 PR 2
negative deficiencies, predictability in roll out response, roll rate control very good, pretty good, very small corrections difficult to make, overall very good

Pilot: SF
Date: 29 July

Test 1 τ = .45 K = 49.38 PR 5
very sluggish, as I approach target--can't feel where I should line up with target, smooth but excessive time delay

Test 2 τ = .45 K = 123.42 PR 3
nice reacting system, tended to overshoot but didn't task me, don't know how system reacts to my input, better than before, good feedback or stick motion, comfortable

Test 3 τ = .45 K = 166.66 PR 2
good system, easy to control, good feedback, good rate and position, slight overshoot, (I have to) anticipate targets

Test 4 τ = .25 K = 400 PR 1.5
really sharp, used very discrete inputs--almost digital, stopped W whenever I wanted to

Test 5 τ = .25 K = 160 PR 7
slow in responding, couldn't get it where I wanted, by the

time I got there target moved, need lots of compensation, good on small error not large

Test 6 τ = .25 K = 320 PR 2
I like it, able to precisely stop motion, bank rate is better on roll in

Test 7 τ = .8 K = 15.63 PR 8
time delay too large, no roll rate, no roll out, have to lead system, target is faster than me, command signal was contolling me

Test 8 τ = .8 K = 39.1 PR 7
rate slope not linear, couldn't judge input, very sluggish, overshot, good for catching up but not for stopping

Test 9 τ = .8 K = 237.5 PR 4
responsive but abrupt, mushy handling, good course correction but no fine correction, time delay acceptable, felt more comfortable to make little inputs

Test 10 τ = .15 K = 1111.1 PR 1
best one so far, easy to line up very responsive, very easy to control, no time delay, a little abrupt, easy to predict stick movement to correct error

Test 11 τ = .15 K = 444.44 PR 4
higher time delay needed to lead the command signal, crisp in eliminating input, slow in getting input in, behind the power curve but didn't have to chase target, not as good as Test 10, for larger errors this system would be very deficient

Test 12 τ = .15 K = 666.66 PR 1
large errors show a slight objectionable time delay in input, crisp tracking good, didn't need to lead

Test 13 τ = .1 K = 1000 PR 3
slow moving target, I couldn't follow it, needed discrete inputs (steps), not objectionable for large errors

Test 14 τ = .1 K = 750 PR 3
slight tendency to overshoot not quite as crisp, good tracking, inputs smooth and reasonable, didn't need to move the stick very much

Random Step

Pilot: DS
Date: 9 Aug

Test 1 τ = .45 K = 49.38 PR 7

real slow, required full stick deflection

Test 2 τ = .45 K = 123.42 PR 3
much faster response, slight tendency to overshoot

No Test 3, could not improve stick response compared to Test 2.

Test 4 τ = .25 K = 400 PR 2
much faster, less tendency to overshoot, liked it

Test 5 τ = .25 K = 160 PR 3
little too slow, less tendency to overshoot

Test 6 τ = .25 K = 360 PR 2
real good, easier to control straight and level

Test 7 τ = .8 K = 15.63 PR 7.5
too slow, needed to use full stick deflection, too stable to oscillate

Test 8 τ = .8 K = 39.1 PR 7
slightly better, still required full stick deflection, large tendency to overshoot, used full stick to start and full stick to stop

Test 9 τ = .8 K = 125 PR 5.5
has big overshoot problem, responded fairly quickly, need a lot of compensation to control overshoot

Test 10 τ = .15 K = 1111.1 PR 5.5
great tendency to overcontrol, had to compensate, very quick response, just too sensitive, no appreciable overshoot

Test 11 τ = .15 K = 444.44 PR 2
better, more easily controlled, no appreciable overshoot

Test 12 τ = .15 K = 533.33 PR 1
very nice, no overshoot, quick response, good tradeoff between response and stability

Test 13 τ = .1 K = 1000 PR 2
good, no overshoot, quick response

Test 14 τ = .1 K = 600 PR 1.5
good, no tendency to overshoot, quick response but controllable

Pilot: MK
Date: 12 Aug

Test 1 τ = .45 K = 49.38 PR 4
easy to fly, doesn't matter what I do W will eventually get

there

Test 2 τ = .45 K = 123.42 PR 4.5
kind of sluggish, tended to overshoot, I did not like this

Test 3 τ = .45 K = 44.44 PR 4
easier to fly, better because the W responded more quickly, good damping, not too much overshoot

Test 4 τ = .25 K = 400 PR 3
like that better, good damping, not much overshoot, quick response

Test 5 τ = .25 K = 160 PR 3.5
just as easy as before, I don't like the way it feels

Test 6 τ = .25 K = 500 PR 3.5
this is as good as I can do it, if it responds quickly, I like it, if it overshoots much I don't like it

Test 7 τ = .8 K = 15.63 PR 4
too much inertia, response is too slow, overshoots, uselessly atypical--never bang an airplane against stops except in acrobatics, easy to maintain task

Test 8 τ = .8 K = 39.1 PR 5
too much inertia, response is quicker but harder to fly

No Test 9, could not improve on Test 7.

Test 10 τ = .15 K = 1111.1 PR 3
nice airplane, very responsive, quick no inertia, as soon as I move stick airplane moves

Test 11 τ = .15 K = 444.44 PR 3
different but flies nice, response is slow, no overshoot

Test 12 τ = .15 K = 1333.33 PR 3
I like this the best, quick response

Test 13 τ = .1 K = 1000 PR 3
like this better, response is quicker, less overshoot

Test 14 τ = .1 K = 750 PR 2.5
responds real quick and stops, absolutely no overshoot, this is the best one

Pilot: MM
Date: 9 Aug

Test 1 τ = .45 K = 49.38 PR 6
too dull, stick not sensitive enough, had to overcompensate

Test 2 τ = .45 K = 123.42 PR 6
sensitivity has not changed, definite improvement in stick response, quicker, not bad overall--fair

Test 3 τ = .45 K = 155.55 PR 2.5
better than Test 2, didn't like sensitivity (not enough), speed compensated, easy to control, pretty good overall

Test 4 τ = .25 K = 400 PR 4
good, moderate speed, could be more sensitive

Test 5 τ = .25 K = 160 PR 2
better than Test 4, not as sensitive--almost like being sluggish, I liked it

Test 6 τ = .25 K = 240 PR 1.5
sensitivity real good, nice and smooth movement

Test 7 τ = .8 K = 15.63 PR 5.5
too slow, W had some momentum, dull reacting, had to really push the stick

Test 8 τ = .8 K = 39.1 PR 5
sensitivity better, kind of dull, not much inertia--about the same as before, slightly better than Test 7

Test 9 τ = .8 K = 100 PR 4
sensitivity real good, liked the way it moved, sensitivity helped--compensated for the momentum

Test 10 τ = .15 K = 1111.1 PR 7
moved fast, didn't like it, sensitivity was good (didn't have to move the stick as far)

Test 11 τ = .15 K = 444.44 PR 2.5
much better sensitivity, just right, good response

Test 12 τ = .15 K = 533.33 PR 1
handled real well, good speed in response, sensitivity is good, moved when I wanted it to, felt real smooth, even flow, good overall

Test 13 τ = .1 K = 1000 PR 5
overall pretty fair, sensitivity okay, slightly unstable, felt like it was moving on its own, good speed for correction

Test 14 τ = .1 K = 850 PR 1
good, nothing wrong, smooth, felt good

Pilot: RL
Date: 10 Aug

Test 1 τ = .45 K = 49.38 PR 3
slow roll, initial okay, overshot slightly but easy to overcome, used full stick deflection

Test 2 τ = .45 K = 123.42 PR 2
roll rate faster, initial response good, overall predictable, liked it better, less stick deflection, less overshoot

Test 3 τ = .45 K = 444.44 PR 2
nothing unpleasant, roll in good, roll out rate not the same, very predictable, slight overshoot but not PIO

Test 4 τ = .25 K = 400 PR 3
slower system, less responsive, predictable, large correction gave slight overshoot but no PIO

Test 5 τ = .25 K = 160 PR 2
better, more predictable especially in rolling out, more solid, roll rate good, most predictable

Test 6 τ = .25 K = 208 PR 2
good and predictable, easiest task to accomplish so far

Test 7 τ = .8 K = 15.63 PR 4
didn't like it, very sluggish, long roll in, small corrections hard to make, large corrections are easier, no PIO

Test 8 τ = .8 K = 39.1 PR 4
improved response, small corrections easier, tend to overshoot on large corrections, still sluggish, no PIO

Test 9 τ = .8 K = 100 PR 4
sluggish, have to force overshoot, heavy workload

Test 10 τ = .15 K = 1111.1 PR 3
good response, tendency to overshoot but less than before, very sensitive--not what you want for ILS final, otherwise good

Test 11 τ = .15 K = 444.44 PR 3
better than before, less sensitive especially for small corrections, goo as far as roll out

Test 12 τ = .15 K = 500 PR 3
minimal pilot compensation

Test 13 τ = .1 K = 1000 PR 3
good, better than the last test (Test 12), roll out response predictable, less tendency to overshoot

Test 14 τ = .1 K = 750 PR 2

roll out predictable, no pilot workload

Pilot: SF
Date: 5 Aug

Test 1 τ = .45 K = 49.38 PR 6
very slow responding, needed considerable lead, not precise--couldn't tell where I would end up, had to put lead in, time delay okay

Test 2 τ = .45 K = 123.42 PR 8
roll PIO problem, didn't know when to take rate out, difficult to control, too much compensation needed

Test 3 τ = .45 K = 88.88 PR 4
best one, (had to) kill motion with opposite input--pilot lead, hard to predict, rate acceptable, no real PIO

Test 4 τ = .25 K = 400 PR 7
PIO (pilot induced oscillation), too abrupt, rate seemed high

Test 5 τ = .25 K = 160 PR 2.5
very predictable, a little sluggish, good system, very tolerable

Test 6 τ = .25 K = 140 PR 2
good system, frequency a little low, could be more responsive, very tolerable, like it

Test 7 τ = .8 K = 15.63 PR 7
very sluggish, terrible system, had to wait on response, had to predict when to take out input

Test 8 τ = .8 K = 39.1 PR 8.5
sluggish, PIO prone, time delay hard to manage, verging on uncontrollability at times, not precise, rate too slow, not crisp

Test 9 τ = .8 K = 62.5 PR 5
sluggish, pilot lead required, little PIO, no problem with control, compensation required, phase lad noticeable but not objectionable

Test 10 τ = .15 K = 1111.1 PR 2.5
pretty precise, (I) wanted to let the stick drift into the target, good system

Test 11 τ = .15 K = 444.44 PR 5
breakout force very high, very sluggish, had to wait for the W to move, precise and smooth

Test 12 τ = .15 K = 833.33 PR 2

good system, a little on the abrupt side, had to compensate for the high rate

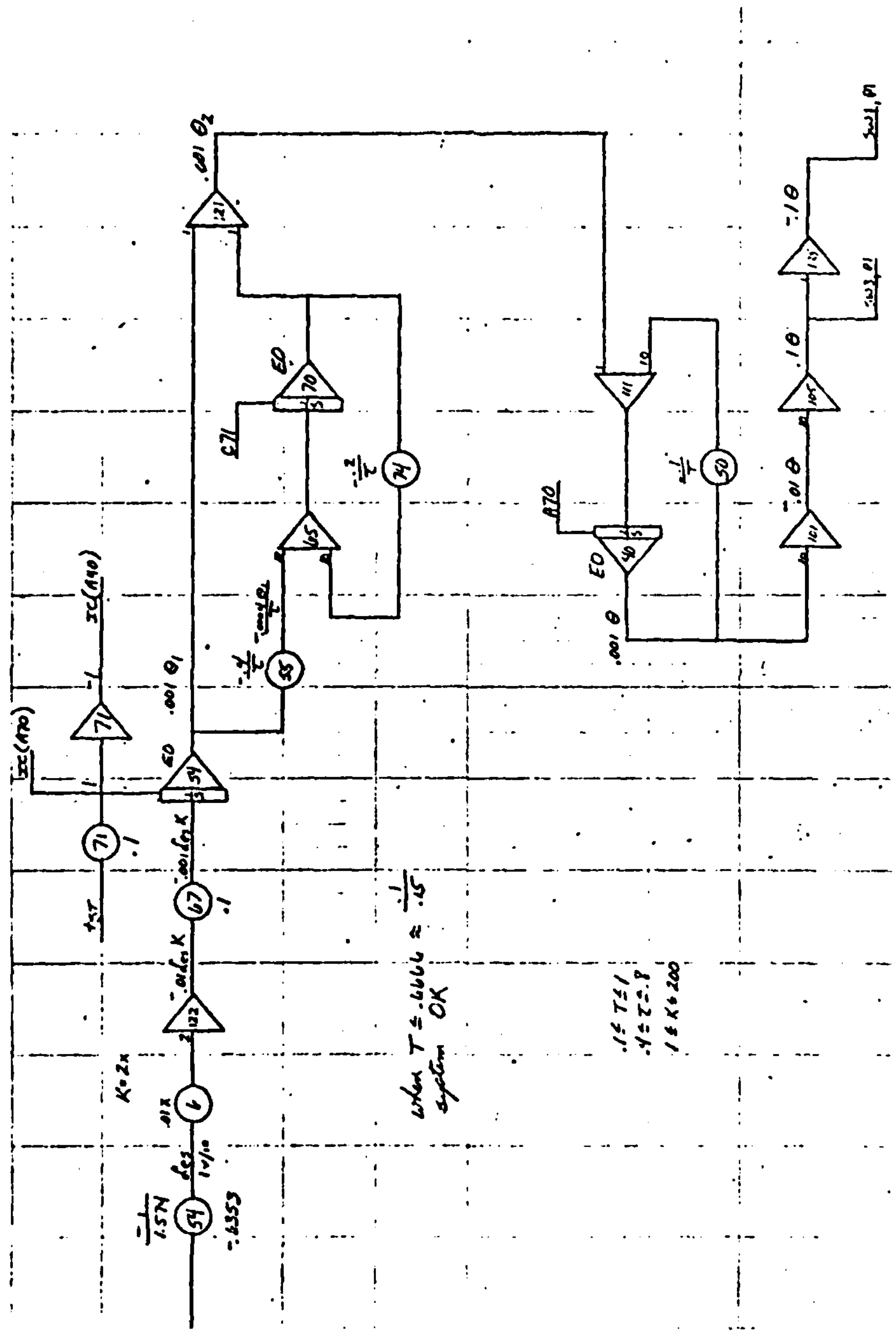
Test 13 τ = .1 K = 1000 PR 2
can't tell much of a difference (from Test 12), the gain is less, seems to be good, (the task is) not exercising me

Test 14 τ = .1 K = 750 PR 3
slight tendency to bobble, (I) can judge the stick however

APPENDIX F

SCHEMATIC FOR EQUATION 5

Figure F-1 is the schematic for Eq (5), the only pitch equation which had no stability problems.



APPENDIX G

SAMPLE STRIP CHART RECORDINGS

The following are sample strip chart recordings. Figures G-1 through G-3 show the Test 1 for MM. Figures G-4 through G-6 show Test 13 for MK. The voltage values in all of the figures are the following:

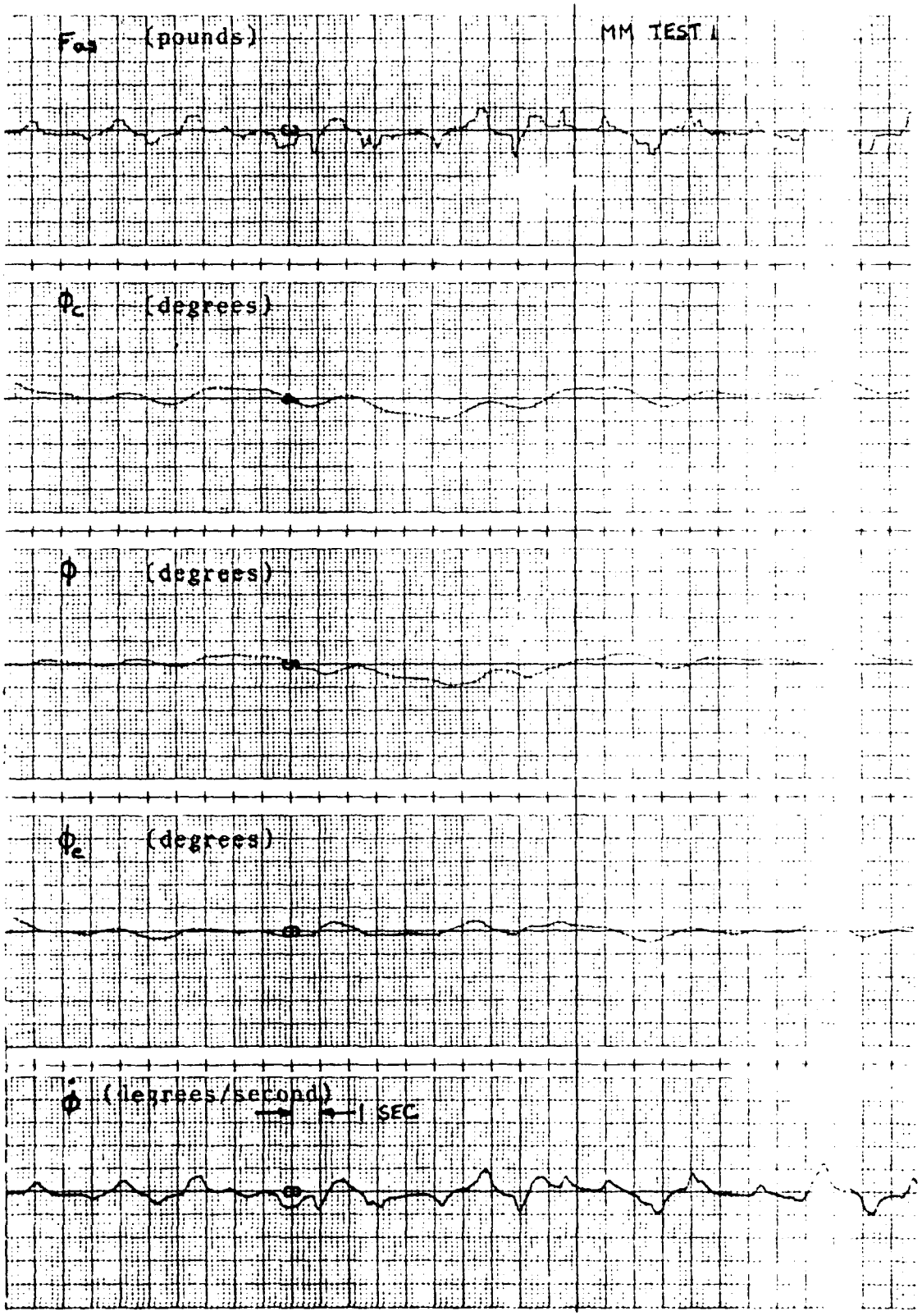
F_{AS} = .05 v/div

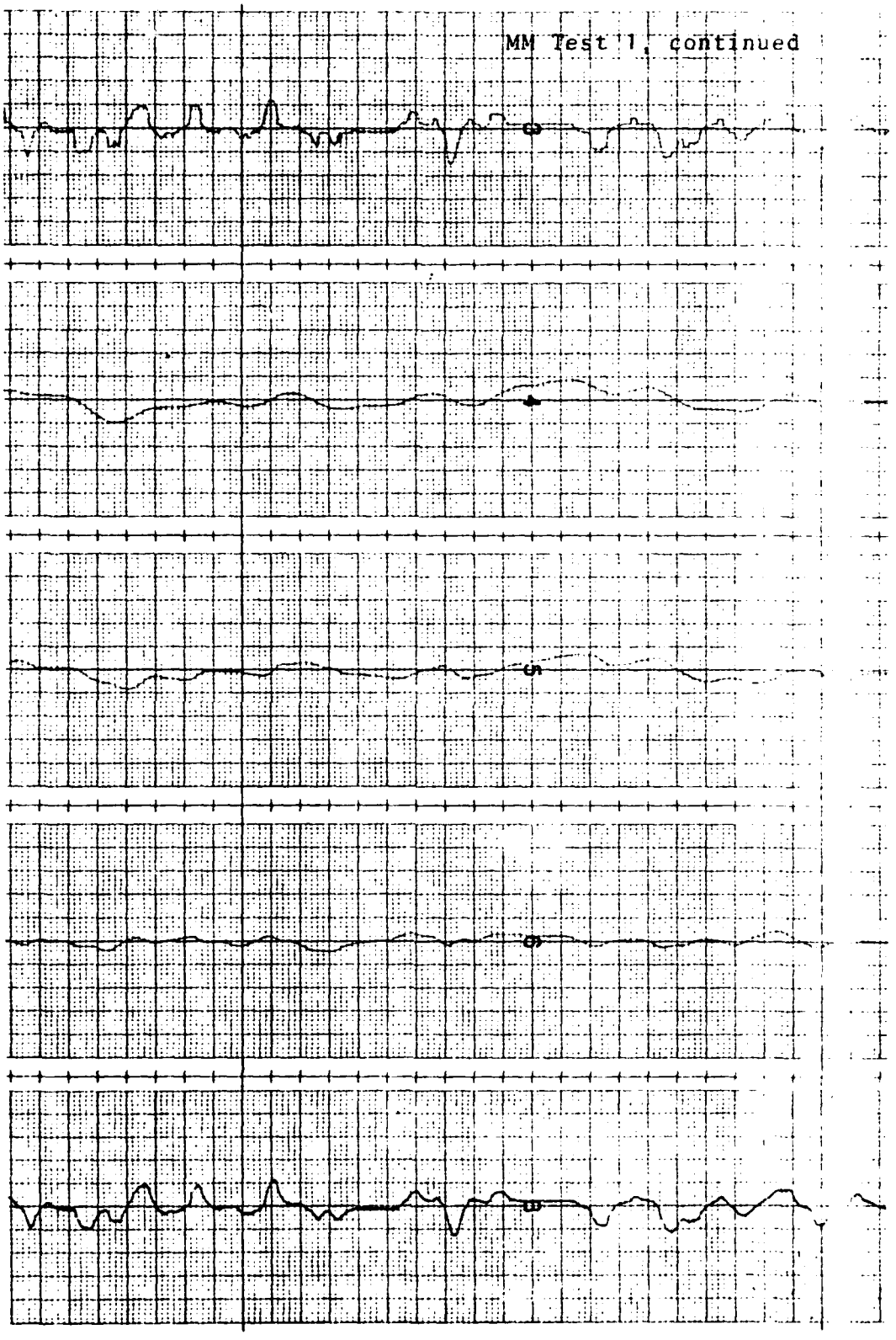
Φ_c = .5 v/div

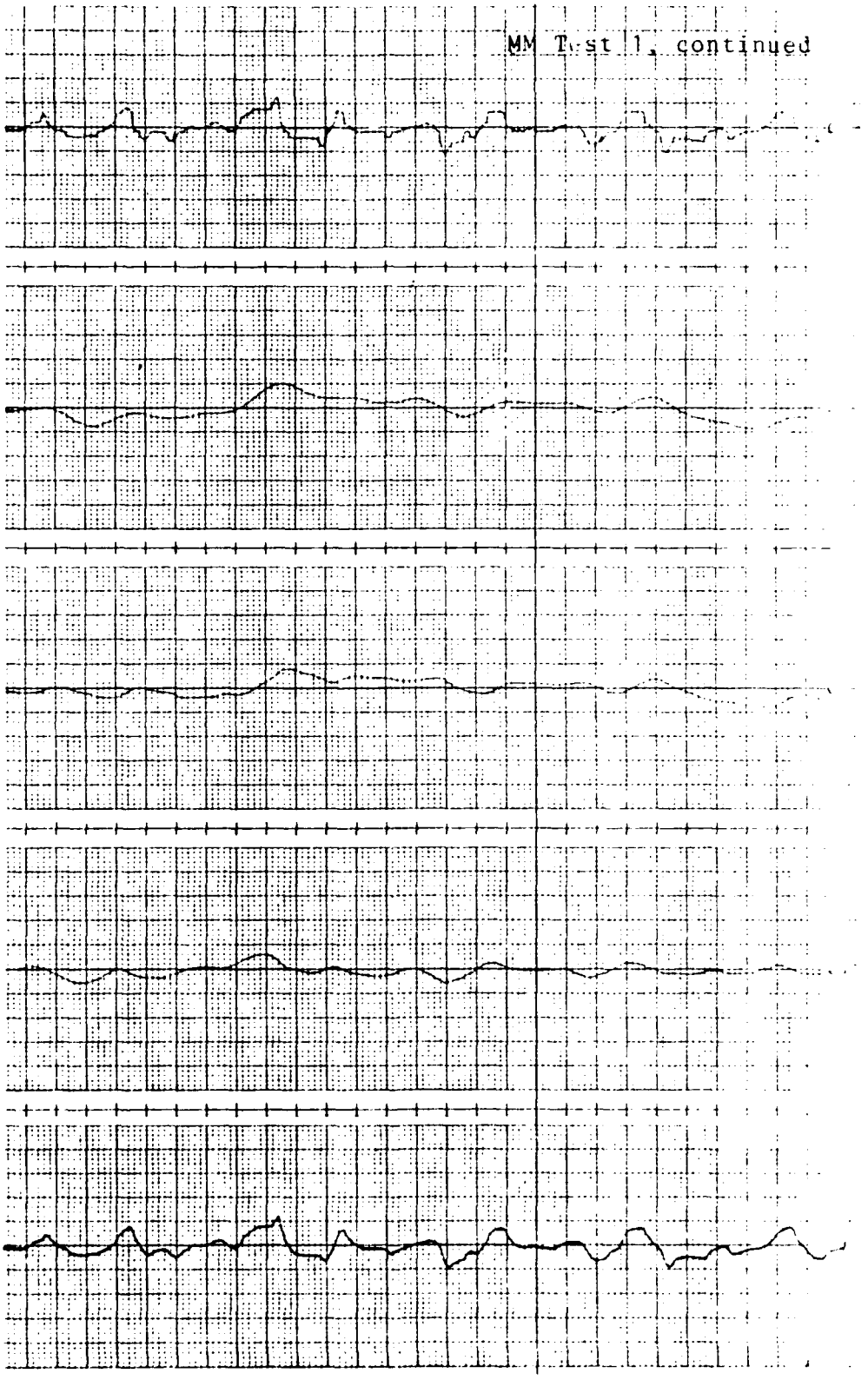
Φ = .5 v/div

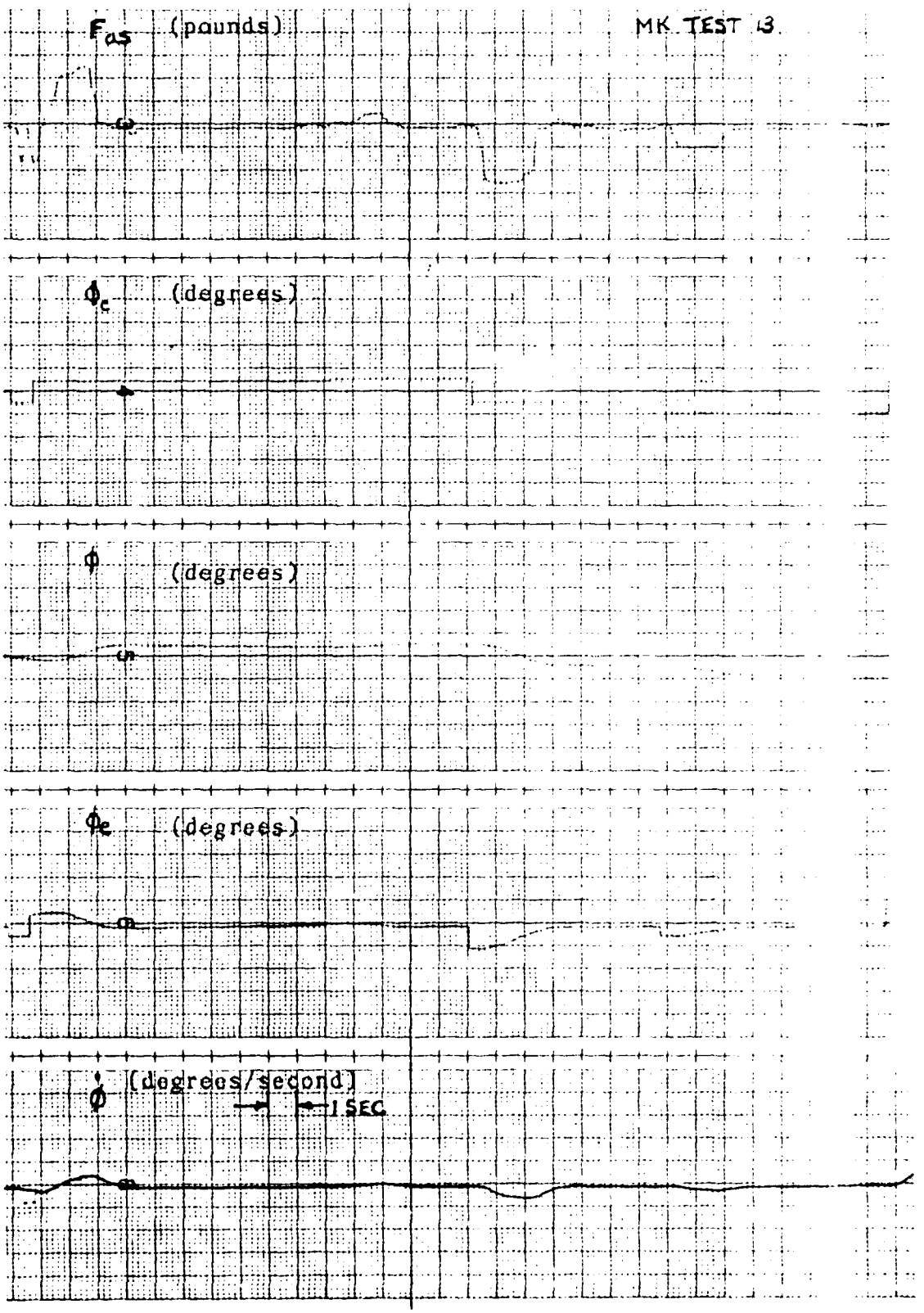
Φ_e = .5 v/div

$\dot{\Phi}$ = .05 v/div

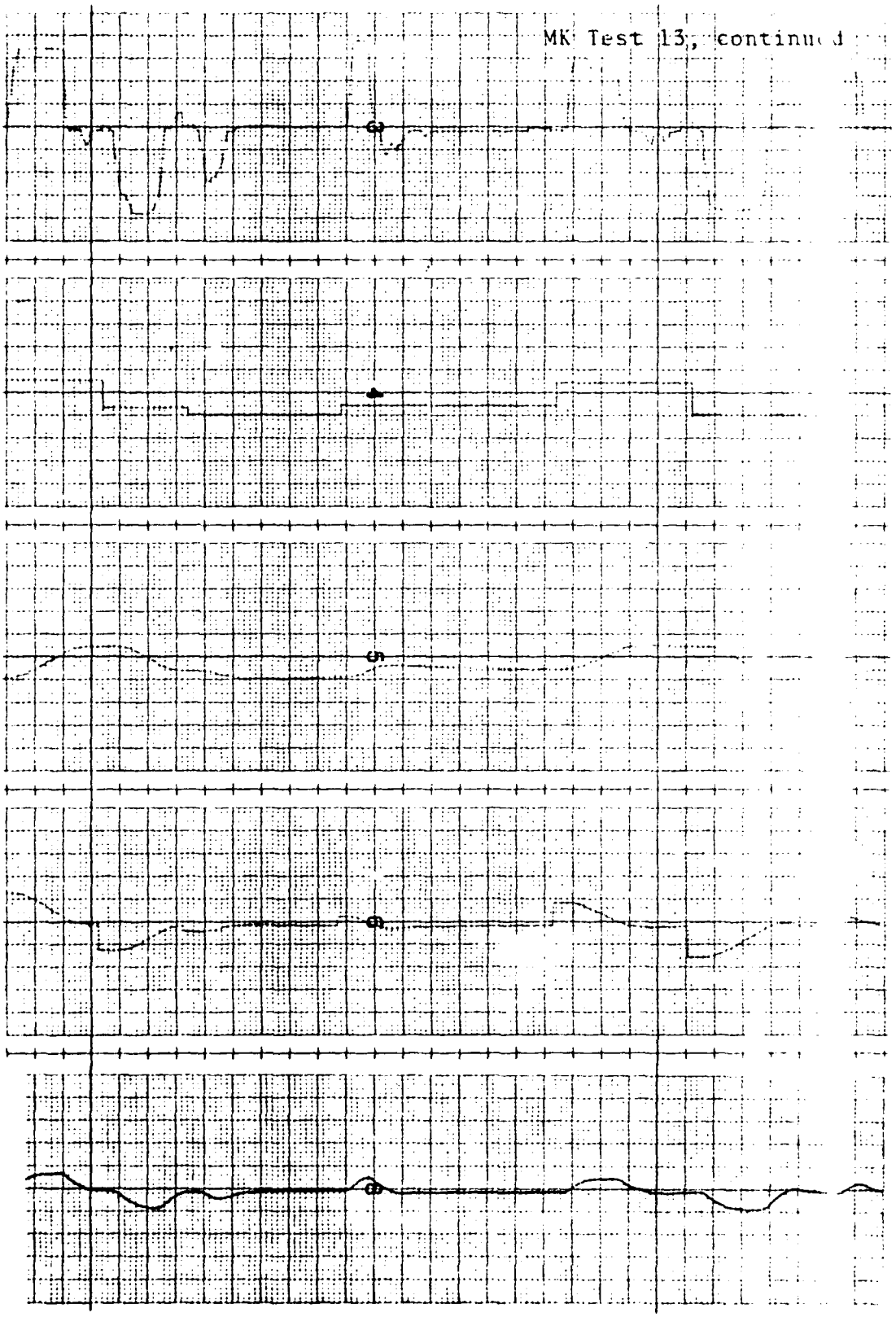

F_a (pounds)
MM TEST
ϕ_c (degrees)
ϕ (degrees)
ϕ_e (degrees)
$\dot{\phi}$ (degrees/second)
1 SEC


MM Test 1, continued

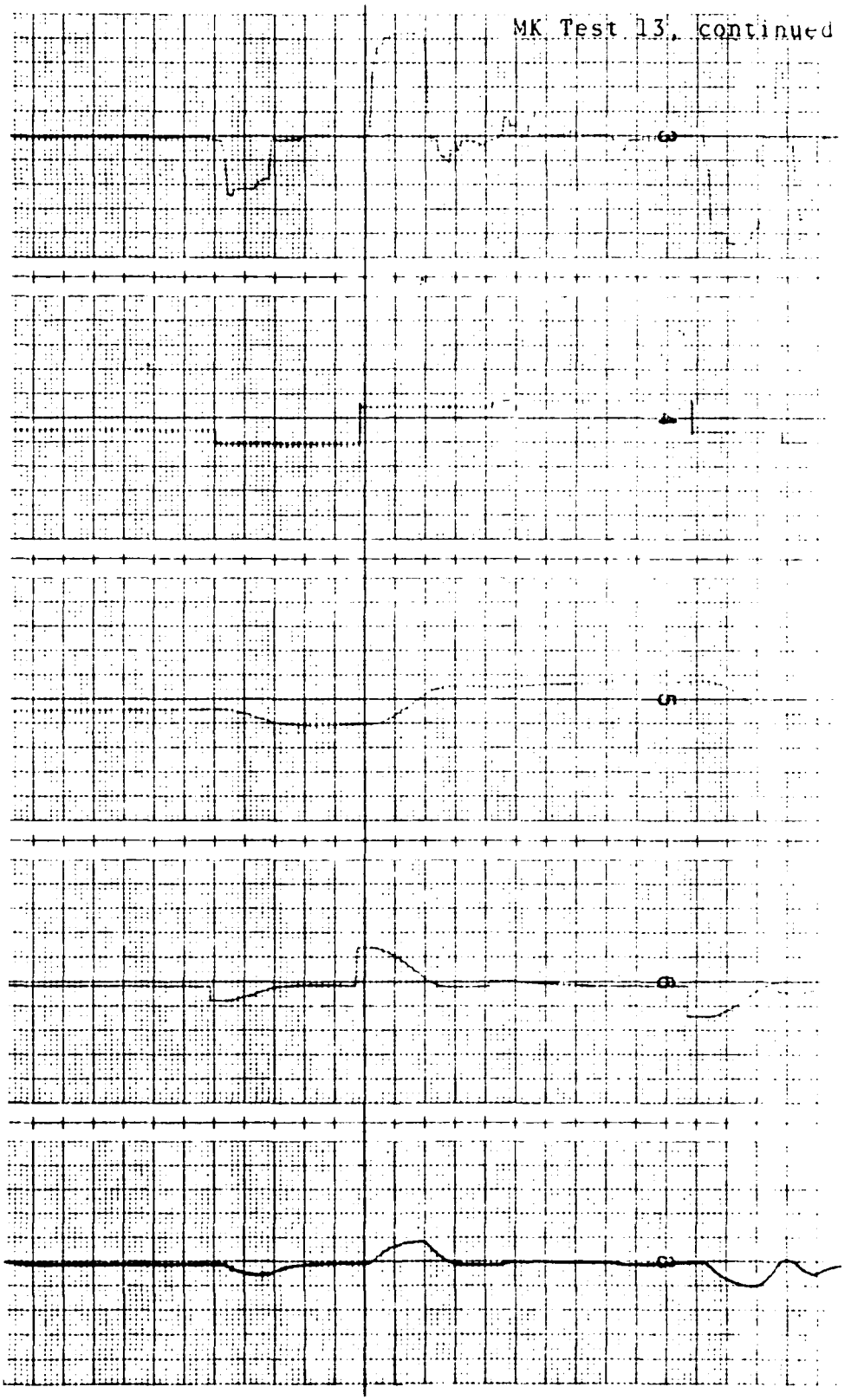

MM Test 1, continued


F_{as} (pounds)
MK TEST 43
ϕ_c (degrees)
ϕ (degrees)
ϕ_e (degrees)
$\dot{\phi}$ (degrees/second)
1 SEC

MK Test 13, continued



MK Test 13, continued



APPENDIX H

TABULATED DATA FOR RMS ERROR AND TIME ON TARGET

The data in this appendix are read from left to right. The first value is located in the top left and last value in the bottom right. The data were printed for every second during a 90-second period. The first 10 values of RMS error were not used because of the physical limitation on the multipliers used (5 millivolts/10 volts). The first 10 values of error were on the order of 0.01V or less, giving an error of 50% or more. The RMS error value was calculated by the formula below.

$$\text{RMS error} = \frac{1}{t}\int_0^t (\text{error})^2\, dt$$

Note: t is the time at any one point.

The mean of RMS is the average of the last 80 values for RMS error.

The list below are those tests where the subject could not improve stick action when the stick gain was changed. Therefore, there were no runs for the following tests:

Test 9 step function MK

Test 3 sum of sine waves DS

Test 14 sum of sine waves DS

DS test 1

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

0.00	1.37	1.70	1.77	1.5[illegible]	1.[illegible]
1.39	1.36	1.29	1.41	1.21	1.[illegible]
1.19	1.65	1.57	1.[illegible]	1.55	1.[illegible]
1.42	1.45	1.37	1.34	1.35	1.[illegible]
1.33	1.29	1.25	1.[illegible]	1.29	1.[illegible]
1.26	1.27	1.27	1.[illegible]	1.26	1.[illegible]
1.25	1.24	1.22	1.20	1.19	1.[illegible]
1.17	1.23	1.22	1.21	1.25	1.[illegible]
1.21	1.21	1.21	1.22	1.19	1.[illegible]
1.39	1.38	1.34	1.36	1.36	1.[illegible]
1.35	1.35	1.36	1.36	1.38	1.[illegible]
1.38	1.39	1.38	1.37	1.37	1.[illegible]
1.42	1.41	1.39	1.44	1.45	1.[illegible]
1.44	1.44	1.45	1.42	1.44	1.[illegible]
1.44	1.45	1.42	1.42	1.42	1.[illegible]

MEAN OF RMS= 1.34

TIME ON TARGET (SECS)

0.20	1.20	1.48	2.24	3.25	[illegible]
5.29	6.53	7.31	8.56	9.56	1[illegible]
11.36	11.45	12.26	13.26	14.53	1[illegible]
16.31	17.38	18.36	19.39	20.40	2[illegible]
22.03	22.85	23.50	24.30	25.40	2[illegible]
27.93	28.05	29.08	30.35	31.08	3[illegible]
33.14	34.14	35.14	35.19	37.20	3[illegible]
38.32	39.32	40.33	40.50	41.52	4[illegible]
43.66	44.68	45.72	46.59	47.74	4[illegible]
48.31	49.31	50.32	51.35	52.34	5[illegible]
54.37	54.35	55.31	56.37	57.03	5[illegible]
58.44	59.46	60.51	61.54	62.47	6[illegible]
63.42	64.58	65.43	66.50	66.50	6[illegible]
68.35	69.35	70.36	71.36	71.76	7[illegible]
73.57	74.60	75.57	76.57	77.62	7[illegible]

DS test 2

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

0.00	1.11	0.64	0.79	0.38	[illegible]
1.11	0.96	1.59	1.07	1.01	[illegible]
1.69	1.75	1.65	1.07	1.52	[illegible]
1.51	1.49	1.45	1.52	1.50	[illegible]
1.51	1.64	1.60	1.58	1.56	[illegible]
1.56	1.50	1.51	1.46	1.50	[illegible]
1.45	1.48	1.42	1.45	1.41	[illegible]
1.45	1.42	1.51	1.53	1.51	[illegible]
1.49	1.48	1.45	1.47	1.53	[illegible]
1.50	1.49	1.50	1.48	1.50	[illegible]
1.50	1.49	1.47	1.46	1.45	[illegible]
1.46	1.44	1.45	1.43	1.41	[illegible]
1.40	1.44	1.42	1.44	1.45	[illegible]
1.47	1.44	1.46	1.45	1.46	[illegible]
1.46	1.46	1.46	1.45	1.45	[illegible]

MEAN OF RMS= 1.49

TIME ON TARGET (SECS)

0.53	1.56	2.56	3.58	4.63	[illegible]
6.61	7.61	7.79	8.25	9.25	[illegible]
10.34	11.35	12.38	13.38	14.39	[illegible]
16.46	17.41	18.49	19.07	19.68	[illegible]
21.29	21.70	22.70	23.73	24.74	[illegible]
26.09	27.13	28.17	29.10	30.15	[illegible]
32.17	33.25	34.22	35.29	36.08	[illegible]
37.48	38.50	39.83	39.49	40.50	[illegible]
42.52	43.53	44.54	45.57	46.56	[illegible]
47.68	48.67	49.72	50.72	51.52	[illegible]
52.96	53.95	54.93	55.97	57.04	[illegible]
59.06	60.06	61.09	62.10	63.11	[illegible]
65.13	66.27	66.32	67.28	68.35	[illegible]
69.52	70.48	71.55	72.52	73.96	[illegible]
74.66	75.71	76.65	77.70	78.68	[illegible]

DS test 4

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.56	2.09	1.58	1.67	1.43	1.
1.26	1.24	1.23	1.45	1.74	1.
1.71	1.71	1.52	1.64	1.52	1.
1.53	1.45	1.45	1.46	1.27	1.
1.41	1.52	1.51	1.50	1.57	1.
1.52	1.60	1.57	1.58	1.54	1.
1.49	1.50	1.48	1.46	1.47	1.
1.44	1.44	1.41	1.42	1.38	1.
1.37	1.37	1.37	1.43	1.46	1.
1.48	1.43	1.45	1.44	1.41	1.
1.52	1.54	1.52	1.55	1.51	1.
1.58	1.58	1.57	1.56	1.55	1.
1.54	1.53	1.52	1.54	1.53	1.
1.55	1.51	1.51	1.51	1.49	1.
1.48	1.47	1.48	1.47	1.46	1.

MEAN OF RMS= 1.50

TIME ON TARGET (SECS)

1.00	1.51	1.88	2.38	2.93	3.
5.25	6.31	7.50	8.13	8.24	9.
10.30	11.29	12.34	13.35	14.36	15.
16.39	17.39	18.38	19.44	20.45	21.
22.52	22.79	23.74	24.78	25.58	26.
26.93	27.95	28.93	29.98	30.98	31.
33.04	34.07	35.03	36.12	37.06	38.
39.12	40.13	41.14	42.16	43.16	44.
45.29	46.21	47.22	47.64	48.29	49.
50.32	51.34	52.37	53.37	54.37	55.
55.83	56.31	57.56	58.56	58.56	59.
60.58	61.59	62.61	63.63	64.63	65.
66.66	67.70	68.71	69.10	69.97	71.
72.00	73.03	74.10	75.05	76.05	77.
78.08	79.07	80.12	81.13	82.16	83.

DS test 5

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.91	1.78	1.91	1.85	1.85	1.81
1.11	0.83	1.36	1.36	1.42	1.45
1.54	1.26	1.25	1.33	1.23	1.17
1.22	1.31	1.31	1.33	1.30	1.33
1.60	1.34	1.39	1.38	1.33	1.37
1.55	1.32	1.32	1.31	1.49	1.47
1.47	1.34	1.34	1.32	1.31	1.31
1.50	1.46	1.44	1.46	1.43	1.43
1.51	1.48	1.48	1.47	1.47	1.47
1.45	1.34	1.32	1.31	1.38	1.39
1.56	1.35	1.35	1.35	1.35	1.31
1.52	1.31	1.30	1.34	1.34	1.28
1.52	1.30	1.31	1.36	1.32	1.32
1.31	1.32	1.31	1.31	1.49	1.47
1.47	1.48	1.47	1.46	1.50	1.51

MEAN OF CASE 1.47

TIME ON TARGET (SECS)

0.15	0.49	1.41	2.41	3.49	5.56
6.60	6.99	7.55	8.15	9.21	10.11
11.21	11.96	12.70	13.71	14.75	15.78
15.75	17.20	17.75	18.55	19.31	20.56
20.92	21.97	22.97	23.53	23.97	24.52
26.00	26.93	27.63	28.02	30.00	31.07
32.07	32.95	33.04	34.35	35.00	36.07
37.12	38.15	39.14	40.17	41.15	41.11
42.34	43.37	44.39	45.04	45.55	46.49
47.65	48.52	48.57	49.52	50.64	51.64
52.64	53.58	54.64	55.57	56.71	57.75
58.77	59.76	60.74	60.16	61.96	63.01
64.02	65.00	66.01	67.06	67.77	68.23
69.23	70.22	71.23	72.27	73.26	74.26
75.33	76.33	77.36	78.35	79.27	79.46

DS test 6

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.12	1.77	1.29	1.25	1.41	1.29
1.14	1.04	1.11	0.33	1.46	1.47
1.54	1.43	1.47	1.59	1.52	1.55
1.55	1.59	1.52	1.51	1.54	1.54
1.54	1.51	1.51	1.45	1.53	1.48
1.45	1.40	1.42	1.40	1.37	1.37
1.36	1.34	1.36	1.31	1.31	1.32
1.30	1.31	1.26	[illegible]	1.28	1.26
1.26	1.32	1.32	1.33	1.30	1.32
1.30	1.29	1.26	1.29	1.26	1.26
1.26	1.33	1.30	1.30	1.30	1.28
1.28	1.28	1.32	1.34	1.33	1.35
1.33	1.32	1.32	1.31	1.33	1.30
1.32	1.30	1.31	1.32	1.30	1.31
1.29	1.31	1.29	1.29	1.29	1.30

MEAN OF RMS= 1.35

TIME ON TARGET (SECS)

0.18	1.16	2.15	3.23	4.22	5.25
6.26	7.29	8.29	9.33	9.85	10.93
11.41	11.88	12.88	13.95	14.93	15.13
15.49	16.51	17.45	17.76	18.79	19.13
20.87	21.83	22.89	23.90	24.89	25.93
26.96	27.94	28.97	30.00	30.97	32.02
33.03	34.03	35.07	36.05	37.10	38.12
39.12	40.12	41.10	42.16	43.18	44.21
45.22	46.32	46.32	47.32	48.35	49.34
50.32	51.34	52.02	52.38	53.87	54.91
55.86	56.12	57.17	58.19	59.17	60.19
61.19	62.22	62.58	63.32	64.37	65.02
65.71	66.73	67.76	68.76	69.78	70.83
71.82	72.87	73.13	74.17	75.16	76.18
77.16	78.23	79.23	80.21	81.23	82.23

DS test 7

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.77	2.22	1.91	1.75	1.72	1.90
1.62	1.56	1.58	1.91	1.16	1.84
1.87	2.20	2.15	2.11	2.07	2.30
2.71	2.76	2.69	2.61	2.58	2.54
2.60	2.63	2.58	2.52	2.49	2.46
2.44	2.41	2.36	2.33	2.30	2.29
2.35	2.35	2.32	2.30	2.27	2.26
2.25	2.20	2.25	2.22	2.20	2.24
2.38	2.39	2.35	2.40	2.38	2.47
2.34	2.32	2.29	2.26	2.33	2.32
2.33	2.30	2.28	2.26	2.26	2.24
2.22	2.21	2.28	2.29	2.28	2.27
2.26	2.27	2.29	2.30	2.28	2.26
2.25	2.24	2.26	2.24	2.23	2.23
2.28	2.27	2.29	2.25	2.24	2.25

MEAN OF RMS= 2.29

TIME ON TARGET (SECS)

0.01	0.38	1.36	2.36	3.41	4.43
5.41	6.45	7.45	8.48	9.53	10.56
10.78	10.75	11.13	12.15	13.19	13.54
13.68	13.69	14.66	15.59	16.74	17.74
18.05	18.09	19.04	20.10	21.07	22.12
25.08	24.08	25.14	26.14	27.19	27.50
27.92	28.47	29.47	30.50	31.50	32.54
33.54	34.55	34.63	35.13	36.13	36.53
38.89	38.93	37.67	37.98	38.54	39.55
40.52	41.59	42.62	43.62	43.76	43.42
44.92	45.98	46.49	47.97	49.01	50.05
50.99	52.07	52.24	52.27	53.07	54.09
55.06	55.02	55.04	56.36	57.53	58.57
59.55	60.41	60.82	61.04	62.06	62.95
62.95	63.26	64.25	65.27	66.24	66.62

DS test 8

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.74	2.10	1.44	1.58	2.38	2.72
2.55	2.36	2.01	2.19	2.14	2.05
1.99	1.90	1.90	1.86	2.10	2.06
2.00	2.00	1.87	1.87	1.82	1.79
1.85	1.82	1.76	1.85	1.81	1.79
1.78	1.74	1.75	1.77	1.75	1.74
1.75	1.77	1.76	1.78	1.73	1.76
1.72	1.71	1.75	1.73	1.71	1.75
1.70	1.70	1.69	1.66	1.65	1.64
1.65	1.62	1.60	1.62	1.61	1.61
1.61	1.58	1.62	1.65	1.62	1.61
1.59	1.59	1.57	1.58	1.56	1.55
1.68	1.67	1.66	1.56	1.56	1.54
1.63	1.63	1.61	1.62	1.61	1.61
1.60	1.59	1.62	1.61	1.60	1.60

MEAN OF RMS= 1.73

TIME ON TARGET (SECS)

0.04	1.04	2.03	3.03	5.50	5.96
4.71	5.66	6.70	7.76	8.71	9.75
10.76	11.76	12.81	13.41	15.01	14.99
15.60	16.60	17.60	18.65	19.64	19.99
20.94	21.93	22.66	22.97	25.98	24.96
25.95	26.99	28.02	28.27	29.04	30.02
31.07	31.09	31.96	32.98	34.00	34.02
35.02	37.10	37.38	38.04	39.03	40.03
41.10	42.14	43.13	44.12	45.12	46.14
47.18	48.22	49.06	49.55	50.27	51.31
52.32	53.36	53.66	54.23	55.22	55.35
57.24	58.24	59.31	60.32	61.33	61.71
62.01	63.00	64.03	65.02	66.05	67.05
68.06	69.07	69.81	70.37	71.40	72.25
73.37	74.35	74.43	75.41	76.43	77.43

DS test 9

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.52	1.76	1.57	2.40	2.59	2.13
2.14	1.92	1.95	1.72	2.09	2.00
1.95	1.87	1.85	1.79	1.78	1.79
1.63	1.86	1.87	1.80	1.83	1.85
1.65	1.85	1.81	1.85	1.87	1.84
1.83	1.80	1.48	1.48	1.47	1.49
1.45	1.45	1.42	1.51	1.51	1.52
1.48	1.47	1.46	1.46	1.45	1.42
1.43	1.42	1.41	1.41	1.40	1.45
1.52	1.51	1.49	1.49	1.49	1.48
1.47	1.46	1.45	1.45	1.44	1.45
1.41	1.42	1.41	1.40	1.40	1.40
1.44	1.49	1.48	1.47	1.46	1.46
1.57	1.56	1.55	1.54	1.55	1.56
1.53	1.52	1.52	1.51	1.55	1.55

MEAN OF RMS= 1.54

TIME ON TARGET (SECS)

0.15	0.74	1.78	2.28	7.81	5.53
4.78	5.80	6.85	7.86	7.90	9.89
9.71	10.73	11.71	12.74	13.74	14.79
15.78	16.81	17.86	18.79	19.85	20.74
20.99	21.89	22.89	23.73	24.72	25.69
26.73	27.76	28.79	29.79	30.82	31.80
32.84	33.87	34.85	35.89	36.97	38.09
37.93	38.97	40.02	41.00	41.99	43.02
44.01	45.07	46.03	47.08	48.12	49.06
49.08	50.07	51.09	52.09	53.09	54.09
55.11	56.12	57.15	58.19	59.21	60.21
61.22	62.23	63.25	64.25	65.27	66.28
66.91	67.11	68.06	69.11	70.17	71.16
71.17	72.06	73.08	74.11	75.10	76.15
77.12	78.12	79.16	80.20	80.88	81.15

DS test 10

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

5.24	5.14	4.26	3.57	3.44	3.11
2.96	2.83	2.78	[illegible]	2.48	2.40
2.44	2.35	2.27	2.18	2.19	2.11
2.05	2.01	1.96	1.96	1.93	1.[illegible]
1.85	1.90	1.85	1.83	1.82	1.80
1.82	1.82	1.80	1.77	1.82	1.79
1.80	1.75	1.76	1.75	1.76	1.75
1.71	1.72	1.75	1.83	1.69	1.[illegible]
1.66	1.64	1.63	1.63	1.76	1.79
1.80	1.77	1.75	1.74	1.72	1.72
1.70	1.70	1.71	1.[illegible]	1.69	1.[illegible]
1.70	1.68	1.70	1.68	1.69	1.[illegible]
1.64	1.66	1.65	1.64	1.61	1.[illegible]
1.63	1.64	1.66	1.64	1.[illegible]	1.[illegible]
1.63	1.63	1.62	1.60	1.61	1.[illegible]

MEAN OF RMS= 1.80

TIME ON TARGET (SECS)

0.05	0.21	0.54	1.08	3.11	5.11
4.14	4.58	5.70	6.71	7.53	[illegible]
9.08	10.08	11.06	12.03	13.14	14.15
15.15	16.19	17.16	18.20	19.23	20.[illegible]
21.23	21.27	22.25	23.28	24.25	25.[illegible]
26.00	26.48	27.49	28.46	29.78	30.[illegible]
30.83	31.84	32.89	33.96	34.25	35.[illegible]
36.25	36.68	37.65	38.65	39.62	40.[illegible]
41.63	42.61	43.64	44.64	45.01	47.11
46.25	47.25	48.27	48.79	49.81	50.7[illegible]
51.61	52.79	53.22	54.23	55.24	56.[illegible]
56.63	57.59	58.68	59.66	60.68	61.78
62.63	63.63	64.08	65.06	66.06	67.[illegible]
68.16	68.55	69.56	70.38	71.42	72.43
73.05	73.66	74.68	75.[illegible]1	76.93	77.56

DS test 11

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

5.20	0.79	2.05	1.56	1.57	1.46
1.33	2.15	1.72	1.65	1.83	1.75
1.71	1.65	1.79	1.75	1.74	1.65
1.65	1.59	1.57	1.60	1.61	1.54
1.50	1.46	1.45	1.43	1.45	1.45
1.42	1.45	1.43	1.57	1.59	1.57
1.38	1.57	1.35	1.53	1.34	1.52
1.34	1.55	1.34	1.56	1.53	1.51
1.31	1.27	1.51	1.29	1.28	1.50
1.26	1.27	1.37	1.35	1.37	1.35
1.35	1.36	1.35	1.34	1.33	1.34
1.33	1.34	1.32	1.31	1.33	1.31
1.32	1.30	1.30	1.29	1.28	1.29
1.29	1.28	1.27	1.27	1.28	1.28
1.25	1.26	1.25	1.28	1.29	1.27

MEAN OF RMS= 1.40

TIME ON TARGET (SECS)

0.13	1.13	2.11	3.18	4.25	5.13
6.16	6.45	7.56	8.56	9.36	10.41
11.38	11.59	12.61	13.63	14.68	15.71
16.05	17.01	18.09	19.70	19.59	20.55
21.62	22.62	23.64	24.59	25.22	26.23
26.92	27.99	29.00	30.02	31.04	32.03
33.05	34.05	35.06	36.09	37.10	38.13
39.14	39.50	40.48	41.53	42.52	43.52
44.53	45.59	46.56	46.82	47.91	48.87
49.93	50.76	50.86	51.84	52.39	53.45
54.92	55.88	56.96	57.96	58.97	59.94
60.27	61.36	62.52	63.53	64.57	65.59
66.57	67.40	68.41	69.42	70.45	71.47
72.50	73.55	74.52	75.50	76.55	77.56
78.56	79.60	80.65	80.80	81.80	82.76

DS test 12

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.72	1.76	1.57	1.47	1.57	1.50
1.1[illegible]	1.24	1.57	1.36	1.4[illegible]	1.[illegible]
1.41	1.29	1.54	1.41	1.[illegible]	1.[illegible]
1.55	1.51	1.51	1.49	1.44	1.47
1.40	1.36	1.38	1.37	1.37	1.35
1.34	1.33	1.38	1.37	1.3[illegible]	1.33
1.45	1.45	1.41	1.42	1.49	1.46
1.45	1.46	1.44	1.44	1.41	1.44
1.41	1.33	1.46	1.46	1.45	1.44
1.49	1.50	1.50	1.48	1.45	1.47
1.47	1.47	1.4[illegible]	1.44	1.45	1.43
1.46	1.47	1.47	1.44	1.45	1.44
1.43	1.47	1.44	1.45	1.46	1.4[illegible]
1.44	1.43	1.43	1.42	1.41	1.46
1.41	1.39	1.40	1.39	1.3[illegible]	1.37

MEAN OF RMS= 1.45

TIME ON TARGET (SECS)

0.20	1.20	2.23	3.25	4.2[illegible]	[illegible]
[illegible]	7.03	7.60	8.[illegible]	[illegible]	[illegible]
11.10	12.09	13.04	14.04	14.5[illegible]	[illegible]
16.33	17.38	18.46	19.35	20.43	21.46
22.43	23.44	24.43	25.[illegible]	2[illegible]	[illegible]
28.52	29.43	29.75	30.[illegible]	31.7[illegible]	[illegible]
33.03	33.45	34.[illegible]	35.[illegible]	36.20	[illegible]
39.18	39.22	40.30	41.29	[illegible]	[illegible]
44.33	45.31	45.[illegible]	46.[illegible]	47.59	[illegible]
49.33	49.74	50.[illegible]	51.[illegible]	[illegible]	[illegible]
54.86	55.88	56.91	57.92	[illegible]	[illegible]
60.38	61.21	62.17	63.[illegible]	64.23	[illegible]
66.28	66.[illegible]	67.57	68.[illegible]	[illegible]	[illegible]
71.68	72.67	73.68	74.75	[illegible]	[illegible]
77.77	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

DS test 13

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.92	3.05	2.06	2.29	1.92	1.97
1.75	1.64	1.65	1.63	1.56	1.57
1.79	1.60	1.74	1.73	1.66	1.65
1.65	1.67	1.62	1.65	1.62	1.60
1.55	1.61	1.58	1.57	1.57	1.57
1.50	1.50	1.49	1.46	1.44	1.47
1.45	1.46	1.44	1.42	1.42	1.43
1.42	1.41	1.39	1.38	1.40	1.39
1.40	1.41	1.40	1.37	1.40	1.41
1.42	1.46	1.45	1.45	1.45	1.45
1.44	1.43	1.46	1.45	1.45	1.42
1.42	1.42	1.42	1.40	1.41	1.39
1.38	1.45	1.44	1.44	1.43	1.42
1.42	1.52	1.51	1.50	1.50	1.46
1.47	1.48	1.47	1.47	1.47	1.47

AVG OF RMS= 1.49

TIME OF TARGET (SECS)

0.19	0.48	1.41	[illegible]	3.42	4.03
5.55	6.04	7.01	8.03	9.06	10.06
11.01	11.48	12.01	13.05	14.06	15.09
16.60	17.08	18.01	18.73	19.88	20.38
21.23	22.17	23.22	24.15	25.20	26.20
27.27	28.24	29.24	30.24	31.50	31.70
32.70	33.73	34.77	35.74	36.80	37.77
38.80	39.82	40.84	41.86	42.27	43.21
44.22	45.26	46.27	47.26	48.21	48.47
49.46	50.48	51.14	52.12	53.19	54.19
55.23	56.21	56.57	57.59	58.56	59.54
60.62	61.66	62.67	63.71	64.62	65.71
66.77	67.02	67.97	68.97	69.37	70.36
72.02	72.11	73.06	74.11	75.16	75.15
77.17	78.18	79.20	80.22	81.25	[illegible]

DS test 14

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.94	1.77	1.76	1.86	1.57	1.70
1.73	1.62	1.58	1.66	1.42	1.40
1.51	1.15	1.51	1.27	1.29	1.58
1.50	1.56	1.55	1.25	1.31	1.26
1.27	1.21	1.19	1.15	1.20	1.25
1.29	1.29	1.26	1.29	1.27	1.29
1.26	1.31	1.42	1.40	1.41	1.58
1.57	1.58	1.57	1.40	1.34	1.65
1.34	1.55	1.55	1.50	1.52	1.50
1.55	1.53	1.52	1.29	1.31	1.53
1.29	1.29	1.27	1.29	1.29	1.26
1.26	1.25	1.27	1.56	1.54	1.55
1.57	1.55	1.55	1.55	1.54	1.54
1.53	1.53	1.58	1.56	1.57	1.55
1.56	1.55	1.54	1.54	1.54	1.58

MEAN OF RMS= 1.52

TIME ON TARGET (SECS)

0.20	1.28	2.30	2.81	3.31	4.56
5.36	6.41	7.40	8.41	9.46	10.46
11.46	12.46	13.55	14.54	15.54	16.56
16.89	17.91	18.88	19.91	20.92	21.58
22.97	23.98	25.03	25.03	27.03	28.04
29.37	29.34	30.38	30.70	31.73	32.73
33.73	34.68	34.88	35.92	36.93	37.93
38.98	39.98	40.99	41.99	43.02	44.03
45.07	46.07	47.07	48.12	49.13	50.12
50.77	51.49	52.49	53.52	54.52	55.57
56.56	57.58	58.59	59.61	60.67	61.66
62.63	63.70	64.50	64.38	65.88	66.71
67.07	68.06	69.11	70.10	71.05	72.15
73.17	74.19	74.43	75.46	76.46	77.47
78.50	79.52	80.55	81.55	81.83	82.85

IF test 1

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.24	1.95	1.12	1.25	1.22	1.21
1.33	1.11	1.11	1.17	1.30	1.33
1.35	1.11	1.32	1.18	1.16	1.26
1.42	1.41	1.31	1.36	1.35	1.32
1.35	1.29	1.34	1.30	1.20	1.27
1.30	1.23	1.34	1.34	1.34	1.35
1.33	1.31	1.32	1.29	1.30	1.30
1.28	1.28	1.26	1.25	1.25	1.23
1.25	1.24	1.24	1.22	1.23	1.21
1.23	1.18	1.20	1.19	1.20	1.20
1.19	1.19	1.19	1.17	1.18	1.18
1.17	1.16	1.21	1.22	1.20	1.22
1.19	1.18	1.20	1.19	1.24	1.25
1.24	1.26	1.24	1.25	1.25	1.24
1.25	1.22	1.25	1.22	1.22	1.21

MEAN OF RMS= 1.25

TIME ON TARGET (SECS)

0.03	0.88	1.80	2.58	3.83	4.94
5.91	6.96	7.94	8.40	8.69	9.71
10.74	11.74	12.73	13.75	14.73	15.68
15.66	16.49	17.53	18.56	19.54	20.49
21.53	22.59	23.57	24.62	25.59	26.56
27.60	28.64	28.74	29.28	30.32	31.28
32.34	33.32	34.33	35.32	36.32	37.32
38.38	39.34	40.37	41.39	42.37	43.38
44.43	45.43	46.44	47.47	48.41	49.37
50.47	51.49	52.49	53.48	54.53	55.51
56.48	57.51	58.56	59.57	60.57	61.54
62.61	63.50	63.48	64.56	65.32	66.35
67.33	68.33	69.40	70.40	70.36	71.06
72.02	73.05	74.05	75.03	76.06	77.06
78.08	79.08	80.12	81.15	82.15	83.14

test 2

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.52	1.58	1.83	1.67	1.65	1.70
1.40	1.30	1.29	1.27	1.25	1.24
1.23	1.23	1.11	1.52	1.57	1.48
1.51	1.47	1.46	1.44	1.47	1.51
1.54	1.56	1.51	1.54	1.48	1.51
1.47	1.44	1.44	1.41	1.43	1.40
1.40	1.53	1.54	1.53	1.54	1.55
1.53	1.52	1.49	1.49	1.48	1.45
1.46	1.45	1.46	1.46	1.43	1.46
1.46	1.45	1.44	1.47	1.43	1.45
1.47	1.45	1.41	1.42	1.42	1.41
1.41	1.41	1.40	1.40	1.41	1.40
1.39	1.38	1.38	1.39	1.38	1.37
1.36	1.36	1.35	1.36	1.34	1.35
1.33	1.34	1.34	1.31	1.32	1.34

MEAN OF RMS= 1.43

TIME ON TARGET (SECS)

0.06	0.59	0.71	1.58	2.75	3.75
4.73	5.74	6.76	7.81	8.81	9.81
10.81	11.85	12.81	12.91	13.30	13.49
14.53	15.53	16.54	17.54	18.30	18.45
19.43	20.46	21.44	22.47	23.50	24.47
25.52	26.52	27.53	28.50	29.57	30.53
31.54	31.75	32.22	33.23	34.24	35.22
36.30	37.27	38.27	39.27	40.28	41.31
42.32	43.31	44.31	44.42	44.96	45.96
46.96	47.97	48.96	50.04	51.03	51.11
52.03	53.08	54.09	55.07	56.11	57.11
58.12	59.12	60.17	61.18	62.18	63.17
64.20	65.11	65.17	66.21	67.22	68.18
69.21	70.22	71.22	72.23	73.28	74.27
75.23	76.28	77.31	78.30	79.31	79.50

MK test 3

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.24	1.37	1.71	1.57	1.22	1.20
1.57	1.67	1.66	1.53	1.54	1.54
1.48	1.46	1.50	1.53	1.29	1.54
1.53	1.54	1.28	1.52	1.27	1.54
1.51	1.54	1.48	1.49	1.45	1.48
1.57	1.58	1.57	1.55	1.52	1.54
1.63	1.60	1.59	1.57	1.55	1.54
1.54	1.55	1.62	1.54	1.59	1.51
1.58	1.57	1.53	1.55	1.56	1.53
1.53	1.54	1.52	1.50	1.50	1.48
1.49	1.49	1.48	1.48	1.47	1.49
1.48	1.49	1.48	1.46	1.48	1.45
1.46	1.44	1.44	1.44	1.42	1.44
1.43	1.46	1.46	1.45	1.46	1.45
1.45	1.44	1.42	1.44	1.43	1.43

MEAN OF RMS= 1.49

TIME ON TARGET (SECS)

0.08	0.71	1.68	2.71	3.70	4.71
5.73	5.69	6.16	7.19	8.16	9.21
10.18	11.19	12.19	13.21	14.21	15.23
16.26	17.21	18.26	19.23	20.26	21.06
21.02	21.73	22.78	23.75	24.77	25.52
25.63	25.88	26.83	27.70	28.88	29.92
30.92	31.94	32.97	33.94	34.98	35.98
36.98	37.74	37.78	38.53	39.58	40.48
41.58	42.58	43.62	44.58	45.29	45.57
46.86	47.91	48.66	49.59	50.91	51.92
52.49	52.68	53.91	54.57	55.93	56.52
56.92	57.64	58.87	59.67	60.95	61.87
62.95	63.90	64.95	65.92	66.91	67.92
68.96	69.57	69.70	70.72	71.71	72.71
73.75	74.73	75.70	76.72	77.76	78.77

MK test 4

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.77	1.80	1.45	1.25	1.22	1.29
1.12	1.25	1.05	1.12	1.18	1.02
0.98	0.94	0.95	1.04	1.04	1.06
0.99	1.03	1.09	1.01	1.04	1.07
1.07	1.05	1.05	1.05	0.97	1.07
1.17	1.15	1.13	1.21	1.23	1.24
1.21	1.26	1.22	1.21	1.20	1.16
1.10	1.17	1.18	1.16	1.20	1.19
1.20	1.17	1.18	1.18	1.16	1.17
1.14	1.15	1.17	1.23	1.26	1.25
1.27	1.25	1.25	1.25	1.23	1.24
1.23	1.24	1.28	1.29	1.26	1.29
1.28	1.27	1.26	1.26	1.27	1.27
1.24	1.26	1.25	1.26	1.36	1.35
1.34	1.35	1.34	1.33	1.40	1.40

MEAN OF RMS= 1.19

TIME ON TARGET (SECS)

0.01	0.70	1.75	2.71	3.73	4.76
5.76	6.83	7.79	8.79	9.73	10.77
11.81	12.81	13.84	14.81	15.85	16.86
17.86	18.68	19.91	20.85	21.92	22.90
23.94	24.94	25.94	26.97	27.96	28.88
29.98	29.94	30.95	31.48	31.77	32.78
33.79	34.74	35.79	36.78	37.84	38.79
39.89	40.87	41.85	42.87	43.12	43.97
44.97	46.01	47.01	48.01	48.98	50.04
51.02	52.08	53.06	53.09	54.02	55.05
56.06	57.11	58.15	59.12	60.11	61.12
62.11	62.98	63.07	64.06	65.05	66.10
67.08	68.10	69.08	70.11	71.15	72.12
73.07	74.20	75.15	76.08	76.11	78.97
77.97	78.98	79.97	81.00	81.02	82.00

MK test 5

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

0.00	1.37	1.57	1.25	1.37	1.11
1.05	1.11	0.91	1.17	0.95	0.85
1.11	1.05	0.88	0.96	1.01	1.02
1.05	1.14	1.24	1.23	1.18	1.20
1.24	1.27	1.28	1.24	1.27	1.27
1.25	1.23	1.22	1.22	1.22	1.19
1.19	1.17	1.19	1.18	1.20	1.25
1.25	1.24	1.25	1.22	1.23	1.30
1.27	1.29	1.27	1.25	1.27	1.26
1.25	1.25	1.23	1.25	1.23	1.25
1.22	1.23	1.25	1.24	1.24	1.24
1.24	1.25	1.26	1.27	1.24	1.25
1.26	1.25	1.25	1.24	1.24	1.23
1.23	1.23	1.23	1.24	1.25	1.23
1.22	1.22	1.23	1.23	1.21	1.21

MEAN OF RMS= 1.21

TIME ON TARGET (SECS)

0.29	1.34	2.34	3.33	4.34	5.39
6.34	7.41	8.35	9.41	10.41	11.44
12.41	13.46	14.41	15.48	16.45	17.48
18.49	19.04	19.48	20.48	21.52	22.53
23.28	25.45	24.49	25.45	26.47	27.48
28.53	29.53	30.48	31.52	32.53	33.53
34.54	35.60	36.53	37.54	38.32	38.75
39.65	40.69	41.73	42.73	43.74	43.77
44.22	45.26	46.26	47.27	48.31	49.29
50.31	51.29	52.33	53.32	54.34	55.34
56.37	57.36	58.34	58.81	59.59	60.64
61.49	61.58	62.57	63.57	64.61	65.56
66.62	67.65	68.63	69.63	70.70	71.67
72.70	72.72	73.67	74.68	75.66	76.71
77.68	78.71	79.68	80.76	81.72	82.77

MX test 6

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.96	2.10	1.70	1.67	1.11	1.20
1.33	1.36	1.29	1.27	1.26	1.25
1.20	1.15	1.07	1.08	1.15	1.23
1.11	1.19	1.16	1.14	1.16	1.16
1.18	1.13	1.15	1.11	1.15	1.17
1.09	1.11	1.15	1.09	1.13	1.20
1.21	1.18	1.21	1.21	1.20	1.20
1.17	1.17	1.15	1.17	1.21	1.27
1.20	1.20	1.20	1.19	1.21	1.20
1.19	1.17	1.20	1.16	1.19	1.18
1.16	1.16	1.16	1.14	1.17	1.19
1.19	1.20	1.19	1.17	1.21	1.22
1.21	1.19	1.20	1.20	1.17	1.20
1.19	1.18	1.13	1.18	1.18	1.13
1.16	1.22	1.23	1.22	1.20	1.20

MEAN OF RMS= 1.18

TIME ON TARGET (SECS)

0.23	0.59	1.30	2.48	3.28	4.36
5.30	6.38	7.30	8.45	9.41	10.41
11.41	12.40	13.45	14.45	15.49	16.49
16.41	17.41	18.46	19.46	20.44	21.45
22.45	23.52	24.52	25.53	26.46	27.50
28.52	29.54	30.53	31.52	32.44	33.54
32.65	33.45	34.52	35.52	36.53	37.52
38.53	39.54	40.53	41.56	42.17	42.52
43.62	44.59	45.53	46.53	47.53	48.52
49.67	50.64	51.72	52.68	53.68	54.73
55.71	56.73	57.72	58.69	59.07	59.59
60.09	61.16	62.06	63.12	63.37	64.45
65.32	66.36	67.56	68.40	69.42	70.47
71.45	72.41	73.45	74.43	75.47	76.48
77.50	77.75	77.83	78.75	79.75	80.77

MK test 7

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.98	2.48	1.82	1.93	1.86	1.90
1.68	1.42	1.38	0.93	1.84	1.98
1.92	2.02	2.13	2.06	2.00	2.03
1.97	1.91	1.86	1.86	1.81	1.85
1.77	1.74	1.70	1.71	1.64	1.63
1.62	1.61	1.56	1.57	1.56	1.55
1.65	1.68	1.69	1.56	1.64	1.65
1.62	1.59	1.59	1.60	1.76	1.80
1.79	1.79	1.77	1.76	1.73	1.74
1.71	1.72	1.71	1.71	1.68	1.68
1.65	1.66	1.75	1.77	1.76	1.75
1.77	1.75	1.75	1.74	1.73	1.71
1.75	1.78	1.77	1.77	1.76	1.74
1.75	1.75	1.74	1.73	1.73	1.74
1.74	1.73	1.72	1.71	1.70	1.69

MEAN OF RMS= 1.74

TIME ON TARGET (SECS)

0.01	0.03	0.76	1.81	2.81	3.81
4.80	5.80	6.85	7.83	7.81	7.81
8.74	9.28	9.24	9.71	10.73	11.78
12.78	13.78	14.78	15.81	16.79	17.80
18.80	19.84	20.85	21.87	22.83	23.87
24.90	25.88	26.93	27.92	28.89	29.90
30.14	30.12	30.95	31.53	32.52	33.52
34.50	35.53	36.54	37.43	37.47	37.44
38.08	39.08	40.10	41.12	42.14	43.09
44.12	45.12	46.12	47.16	48.16	49.21
50.17	50.97	50.98	51.38	52.34	53.32
53.33	53.98	55.08	56.08	57.07	58.04
58.58	58.59	59.38	60.38	61.37	62.37
62.37	63.35	64.40	65.41	66.87	66.86
67.10	68.12	69.11	70.08	71.13	72.13

MK test 8

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

3.16	2.09	1.62	1.57	2.45	2.55
2.49	2.29	2.31	2.25	2.15	2.10
2.06	1.97	2.05	2.06	2.00	1.94
1.92	1.86	1.85	1.80	1.90	1.86
1.85	1.85	1.79	1.77	1.71	1.73
1.72	1.85	1.86	1.85	1.86	1.80
1.79	1.76	1.74	1.75	1.71	1.87
1.82	1.83	1.81	1.81	1.77	1.77
1.79	1.75	1.76	1.70	1.72	1.71
1.89	1.85	1.80	1.81	1.79	1.79
1.76	1.76	1.88	1.90	1.92	1.88
1.87	1.86	1.85	1.85	1.82	1.82
1.81	1.80	1.79	1.78	1.80	1.82
1.81	1.80	1.81	1.79	1.79	1.77
1.77	1.76	1.75	1.75	1.74	1.73

MEAN OF RMS= 1.82

TIME ON TARGET (SECS)

0.04	0.45	1.58	2.58	2.81	2.89
3.49	4.23	4.28	4.96	6.00	6.41
7.98	9.01	9.48	9.76	10.75	11.75
12.75	13.80	14.79	15.81	16.84	17.86
17.70	18.70	19.71	20.83	21.89	22.72
25.77	24.74	25.78	26.76	27.77	28.72
28.78	29.12	29.83	30.87	31.82	31.85
32.55	33.53	34.54	35.59	36.60	36.87
37.84	38.88	39.92	40.82	41.52	42.23
43.92	44.93	45.04	46.34	46.34	47.57
48.37	49.38	49.42	49.66	50.67	51.72
52.72	53.72	54.76	55.73	56.76	57.77
58.78	59.76	60.79	61.82	62.23	62.27
63.30	64.30	65.30	66.33	67.35	68.33
69.32	70.36	71.38	72.37	73.40	74.41

MK test 10

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.77	2.49	2.14	1.76	1.57	1.50
1.63	1.24	1.39	1.48	1.30	1.24
1.63	1.68	1.52	1.62	1.75	1.79
1.77	1.65	1.68	1.76	1.62	1.50
1.56	1.52	1.50	1.48	1.47	1.43
1.48	1.43	1.48	1.51	1.49	1.47
1.47	1.47	1.44	1.43	1.42	1.41
1.38	1.40	1.38	1.40	1.38	1.36
1.36	1.45	1.47	1.45	1.45	1.45
1.41	1.45	1.40	1.39	1.41	1.38
1.38	1.37	1.32	1.35	1.36	1.41
1.40	1.39	1.40	1.39	1.50	1.49
1.48	1.47	1.47	1.46	1.45	1.46
1.44	1.44	1.43	1.44	1.45	1.42
1.41	1.42	1.46	1.45	1.44	1.43

MEAN OF RMS= 1.46

TIME ON TARGET (SECS)

0.14	0.39	1.40	2.43	3.13	4.13
5.13	6.21	7.20	8.19	9.16	10.26
10.61	11.40	12.40	13.33	15.51	14.51
15.51	16.54	17.54	18.54	19.55	20.55
21.60	22.60	23.62	24.60	25.63	26.64
27.62	28.65	28.99	29.93	29.67	30.63
31.90	32.88	33.92	34.54	35.92	36.89
37.92	38.92	39.95	40.93	41.99	42.98
44.01	44.29	44.76	45.77	46.79	47.75
48.78	49.82	50.84	51.88	52.83	53.94
54.82	55.88	56.84	57.89	58.56	59.63
59.31	60.33	61.32	62.35	62.40	63.46
64.40	65.43	66.47	67.43	68.42	69.45
70.48	71.27	71.77	72.76	73.81	74.77
75.81	76.70	77.01	78.01	75.38	80.05

MK test 11

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

0.00	1.37	1.11	1.11	1.11	0.74
0.94	0.96	1.05	1.27	1.34	1.24
1.27	1.26	1.22	1.08	1.09	1.16
1.09	1.47	1.51	1.46	1.55	1.47
1.44	1.45	1.40	1.45	1.37	1.43
1.51	1.47	1.47	1.45	1.43	1.42
1.40	1.40	1.38	1.35	1.37	1.38
1.33	1.34	1.33	1.35	1.32	1.33
1.36	1.39	1.37	1.36	1.39	1.40
1.38	1.38	1.36	1.36	1.35	1.35
1.33	1.34	1.34	1.30	1.31	1.31
1.32	1.31	1.35	1.37	1.38	1.34
1.42	1.43	1.41	1.41	1.40	1.39
1.41	1.38	1.37	1.36	1.37	1.37
1.37	1.35	1.34	1.33	1.34	1.35

MEAN OF RMS= 1.38

TIME ON TARGET (SECS)

0.98	1.98	2.99	3.98	5.01	6.04
7.04	8.06	9.11	9.34	9.95	10.95
11.93	12.99	14.01	15.03	15.09	16.53
16.54	17.60	18.64	19.60	20.62	21.65
22.65	23.69	24.64	25.59	26.69	27.56
27.85	28.80	29.88	30.55	31.87	32.87
33.90	34.94	35.93	36.92	37.94	38.94
40.02	40.97	41.99	42.77	43.02	44.01
45.02	46.03	47.09	48.07	48.54	49.19
50.21	51.22	52.22	53.24	54.27	54.97
55.71	56.72	57.77	58.77	59.77	60.77
61.76	62.77	63.57	63.82	64.82	65.85
65.93	66.90	67.92	68.92	69.93	70.97
72.00	72.98	74.01	74.96	75.98	77.03
78.08	79.03	80.05	81.03	82.06	83.02

NF test 12

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.92	2.25	1.25	0.95	1.32	1.21
1.26	1.25	1.11	1.17	1.25	1.07
1.54	1.57	1.52	1.47	1.43	1.49
1.40	1.39	1.42	1.32	1.35	1.31
1.46	1.48	1.48	1.50	1.42	1.44
1.37	1.40	1.49	1.55	1.54	1.52
1.50	1.48	1.49	1.46	1.46	1.47
1.43	1.41	1.40	1.41	1.40	1.43
1.53	1.50	1.48	1.50	1.49	1.48
1.46	1.46	1.46	1.47	1.46	1.44
1.44	1.47	1.48	1.49	1.48	1.49
1.48	1.49	1.46	1.44	1.47	1.47
1.47	1.45	1.43	1.41	1.47	1.46
1.44	1.44	1.43	1.43	1.42	1.42
1.40	1.39	1.40	1.38	1.39	1.40

MEAN OF RMS= 1.44

TIME ON TARGET (SECS)

0.20	1.26	2.28	3.25	4.25	5.29
6.28	7.29	8.26	9.31	10.31	11.31
11.40	11.70	12.70	13.73	14.73	15.70
16.70	17.74	18.80	19.75	20.75	20.80
21.32	22.35	23.28	24.30	25.35	26.34
27.32	28.40	28.68	29.69	29.73	30.74
31.74	32.73	33.73	34.77	35.77	36.79
37.78	38.78	39.82	40.80	41.85	42.43
42.81	43.81	44.81	45.82	46.79	47.84
48.82	49.82	50.84	51.87	52.88	53.89
54.89	55.43	55.42	56.43	57.42	57.68
58.52	59.49	60.46	61.54	62.55	63.55
64.53	65.58	66.57	67.50	67.63	68.60
69.57	70.66	71.63	72.63	73.66	74.65
75.67	76.68	77.70	78.68	79.76	80.72

MK test 13

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

0.00	1.58	0.91	1.57	1.52	1.03
0.84	1.04	0.91	1.11	1.07	1.62
0.87	1.07	0.95	1.04	1.10	1.20
1.17	1.17	1.21	1.23	1.23	1.16
1.22	1.21	1.17	1.19	1.19	1.15
1.17	1.20	1.13	1.13	1.14	1.16
1.16	1.16	1.17	1.15	1.14	1.15
1.10	1.15	1.18	1.14	1.13	1.14
1.12	1.13	1.19	1.13	1.18	1.14
1.18	1.18	1.24	1.24	1.25	1.22
1.22	1.19	1.21	1.26	1.24	1.19
1.20	1.20	1.19	1.19	1.20	1.19
1.21	1.21	1.20	1.20	1.16	1.15
1.17	1.17	1.17	1.17	1.17	1.18
1.18	1.19	1.16	1.17	1.20	1.20

MEAN OF RMS= 1.17

TIME ON TARGET (SECS)

0.36	1.36	2.39	3.40	4.44	5.40
6.45	7.43	8.48	9.50	10.46	11.44
12.46	13.53	14.44	15.54	16.53	18.52
17.58	18.58	18.63	19.51	20.51	21.48
22.33	23.37	24.35	25.38	26.35	27.32
28.42	29.39	30.40	31.42	32.36	33.49
33.72	34.70	35.77	36.73	37.74	38.74
39.74	40.77	41.82	42.77	43.83	44.82
45.86	46.82	47.88	48.86	49.88	49.84
50.87	51.88	52.01	53.82	54.03	55.07
56.06	57.06	58.09	59.11	60.11	61.11
62.12	63.10	64.15	65.13	66.17	67.03
67.03	68.06	69.07	70.08	71.11	72.07
73.12	74.08	75.08	76.17	77.17	78.11
79.16	80.17	81.16	81.80	82.13	83.20

MK test 14

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.59	1.78	0.91	1.24	1.49	1.20
1.33	1.57	1.44	1.36	1.36	1.24
1.23	1.26	1.22	1.21	1.21	1.20
1.20	1.14	1.14	1.19	1.16	1.15
1.15	1.15	1.09	1.15	1.11	1.15
1.09	1.11	1.15	1.15	1.10	1.09
1.07	1.05	1.07	1.10	1.07	1.06
1.07	1.16	1.20	1.18	1.16	1.17
1.18	1.16	1.17	1.16	1.16	1.16
1.15	1.13	1.14	1.15	1.12	1.15
1.17	1.18	1.17	1.20	1.22	1.20
1.20	1.20	1.21	1.19	1.19	1.18
1.18	1.16	1.18	1.18	1.18	1.15
1.17	1.19	1.22	1.21	1.21	1.20
1.19	1.19	1.18	1.19	1.18	1.17

MEAN OF RMS= 1.17

TIME ON TARGET (SECS)

0.20	1.25	2.19	3.25	4.26	5.25
6.08	6.38	7.36	8.43	9.43	10.43
11.43	12.43	13.46	14.45	15.46	16.49
17.49	18.48	19.54	20.53	21.50	22.54
23.53	24.57	25.55	26.58	27.58	28.59
29.55	30.60	31.59	32.63	33.62	34.60
35.62	36.62	37.58	38.57	39.59	40.58
41.58	42.12	42.66	43.68	44.69	45.72
46.71	47.69	48.71	49.73	50.74	51.74
52.81	53.79	54.79	55.79	56.79	57.49
58.03	59.03	60.04	60.53	60.82	61.85
62.83	63.86	64.83	65.85	66.90	67.90
68.91	69.91	70.95	71.95	72.97	73.92
74.97	75.58	76.25	77.23	78.23	79.21
80.26	81.25	82.26	83.26	84.27	85.31

MK test 1

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.94	1.93	1.70	1.47	1.31	1.28
1.19	1.11	1.20	1.11	1.16	1.06
1.15	1.03	1.07	1.07	1.14	1.17
1.25	1.26	1.19	1.21	1.20	1.15
1.19	1.21	1.15	1.15	1.15	1.15
1.18	1.31	1.37	1.40	1.36	1.44
1.45	1.45	1.41	1.41	1.39	1.39
1.39	1.37	1.35	1.36	1.34	1.45
1.34	1.35	1.36	1.38	1.38	1.36
1.35	1.42	1.45	1.46	1.47	1.45
1.45	1.44	1.42	1.43	1.42	1.43
1.39	1.40	1.39	1.40	1.38	1.39
1.37	1.39	1.45	1.47	1.46	1.46
1.45	1.46	1.45	1.42	1.42	1.43
1.43	1.48	1.46	1.46	1.42	1.45

MEAN OF RMS= 1.34

TIME ON TARGET (SECS)

0.71	0.74	1.39	2.33	3.40	4.36
5.45	6.48	7.46	8.49	9.51	10.55
11.54	12.54	13.59	14.60	14.71	14.74
15.66	16.71	17.69	18.73	19.75	20.78
21.76	22.80	23.76	24.82	25.82	26.89
27.65	27.65	27.65	28.87	29.03	29.08
29.73	30.73	31.75	32.80	33.77	34.75
35.82	36.82	37.82	38.83	39.90	40.90
41.89	42.89	43.27	43.26	44.13	45.16
46.17	46.37	46.36	46.42	47.98	48.13
49.97	50.99	51.98	53.02	54.01	55.08
55.04	57.07	58.04	58.05	59.03	59.42
60.92	61.88	61.75	61.86	62.90	63.70
64.90	65.93	66.95	67.93	68.97	69.99
70.78	70.72	70.93	71.97	72.95	73.96

MN test 2

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.47	1.94	1.44	1.47	1.51	1.45
1.35	1.36	1.17	1.27	1.26	1.50
1.54	1.48	1.49	1.42	1.37	1.56
1.39	1.49	1.47	1.48	1.44	1.41
1.39	1.38	1.38	1.36	1.35	1.36
1.35	1.36	1.48	1.51	1.51	1.48
1.46	1.46	1.55	1.55	1.51	1.45
1.53	1.51	1.52	1.52	1.50	1.49
1.49	1.45	1.46	1.45	1.42	1.43
1.44	1.41	1.40	1.40	1.40	1.39
1.38	1.37	1.38	1.44	1.44	1.44
1.43	1.42	1.41	1.44	1.52	1.49
1.49	1.50	1.43	1.46	1.47	1.46
1.44	1.44	1.45	1.45	1.44	1.44
1.44	1.42	1.41	1.41	1.42	1.41

MEAN OF RMS= 1.44

TIME ON TARGET (SECS)

0.06	0.76	1.51	2.18	3.21	4.25
5.21	6.26	7.28	8.28	9.31	9.38
10.01	11.03	12.05	13.03	14.09	15.05
16.09	16.08	16.75	17.50	18.50	19.78
20.62	21.64	22.40	23.05	24.67	25.50
26.92	27.92	28.63	29.43	29.42	30.42
31.43	32.48	33.68	34.56	34.03	35.12
36.13	37.14	38.18	39.15	40.17	41.17
42.16	43.22	44.25	45.27	46.27	47.27
48.31	49.29	50.33	51.33	52.34	53.33
54.38	55.41	56.39	56.39	57.01	58.05
59.08	60.08	61.08	61.72	61.72	62.57
63.56	64.61	65.56	66.62	67.63	68.65
69.71	70.71	71.70	72.70	73.73	74.75
75.77	76.78	77.81	78.80	79.85	80.86

MM test 3

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.58	1.77	1.29	1.24	0.86	1.01
1.05	0.88	0.58	0.99	1.00	1.11
1.63	1.54	1.67	1.67	1.52	1.53
2.00	1.97	1.92	1.89	1.86	1.83
1.80	1.77	1.77	1.72	1.71	1.74
1.67	1.65	1.63	1.60	1.61	1.60
1.57	1.55	1.58	1.55	1.52	1.52
1.51	1.51	1.55	1.53	1.53	1.52
1.64	1.67	1.66	1.63	1.63	1.64
1.60	1.62	1.65	1.77	1.81	1.81
1.80	1.80	1.79	1.77	1.77	1.74
1.74	1.81	1.84	1.84	1.83	1.82
1.79	1.80	1.79	1.79	1.77	1.76
1.74	1.74	1.74	1.74	1.72	1.71
1.71	1.71	1.72	1.73	1.73	1.72

MEAN OF RMS= 1.68

TIME ON TARGET (SECS)

0.49	1.56	2.54	3.56	4.54	5.51
6.63	7.63	8.63	9.66	10.66	11.65
11.61	12.18	13.21	14.23	15.25	16.91
16.01	16.56	17.56	18.56	19.56	20.59
21.62	22.63	23.62	24.65	25.67	26.69
27.65	28.73	29.75	30.72	31.76	32.75
33.77	34.80	35.80	36.82	37.82	38.83
39.88	40.45	40.82	41.82	42.83	43.84
43.54	43.59	44.58	45.81	46.82	47.84
46.61	49.68	50.31	50.34	50.28	50.53
51.52	52.54	53.58	54.62	55.66	56.69
57.62	57.79	57.97	58.97	59.95	61.03
62.05	63.02	64.08	65.11	66.12	67.10
68.13	69.13	70.16	71.17	72.17	73.21
74.21	75.22	75.37	75.62	76.65	77.69

NM test 4

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.53	1.57	1.82	1.47	1.73	2.02
1.63	1.64	1.61	1.66	1.60	1.63
1.66	1.61	1.49	1.53	1.43	1.43
1.55	1.58	1.57	1.42	1.65	1.53
1.57	1.61	1.58	1.53	1.55	1.54
1.50	1.49	1.66	1.73	1.73	1.78
1.78	1.77	1.75	1.75	1.75	1.75
1.74	1.73	1.72	1.71	1.70	1.68
1.67	1.67	1.65	1.66	1.74	1.75
1.72	1.69	1.71	1.70	1.69	1.69
1.66	1.66	1.69	1.69	1.69	1.73
1.72	1.75	1.74	1.73	1.73	1.70
1.76	1.76	1.75	1.73	1.74	1.72
1.71	1.71	1.69	1.70	1.69	1.69
1.70	1.69	1.69	1.69	1.67	1.67

MEAN OF RMS= 1.66

TIME ON TARGET (SECS)

0.21	0.96	1.96	2.99	3.61	3.99
4.04	5.99	6.93	7.96	9.00	10.05
10.96	12.03	13.09	14.05	15.06	16.08
17.10	18.14	19.15	19.94	19.96	20.98
21.42	22.49	23.48	24.45	25.96	26.92
27.54	28.54	28.97	28.94	29.37	30.10
30.42	31.44	32.47	33.41	34.05	34.45
35.45	36.48	37.45	38.47	39.49	40.47
41.52	42.54	43.56	44.59	44.37	44.55
45.27	46.28	47.32	48.32	49.54	50.42
51.38	52.41	52.48	52.78	53.54	54.41
54.43	54.44	54.96	55.99	57.01	58.06
58.01	58.46	59.48	60.51	61.54	62.55
63.53	64.58	65.58	66.52	67.52	68.54
69.06	69.55	70.56	71.56	72.58	73.41

MM test 5

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.48	2.63	2.25	2.09	1.72	1.73
1.65	1.68	2.10	1.96	1.93	1.95
1.97	2.32	2.29	2.25	2.19	2.14
2.11	2.08	2.10	2.05	1.95	1.93
1.91	1.92	1.99	1.96	1.91	1.89
1.89	1.85	1.82	1.89	1.94	1.91
1.89	1.85	1.86	1.82	1.82	1.79
1.81	1.76	1.77	1.73	1.73	1.72
1.73	1.77	1.77	1.77	1.74	1.75
1.73	1.71	1.71	1.70	1.66	1.66
1.67	1.64	1.64	1.63	1.71	1.76
1.74	1.73	1.72	1.71	1.71	1.69
1.71	1.80	1.82	1.80	1.80	1.79
1.78	1.77	1.76	1.76	1.75	1.72
1.81	1.87	1.87	1.86	1.84	1.85

MEAN OF RMS= 1.84

TIME ON TARGET (SECS)

0.03	0.05	0.76	1.76	2.81	3.81
4.76	5.21	5.23	5.86	6.89	7.91
8.71	8.65	8.61	9.58	10.63	11.61
12.16	13.16	14.18	15.20	16.13	17.23
18.23	18.99	18.99	19.33	20.94	21.96
22.98	23.99	24.99	25.45	25.42	25.44
27.40	28.44	29.46	30.42	31.46	32.47
33.49	34.52	35.54	36.50	37.52	38.57
39.39	39.38	39.83	40.83	41.87	42.86
43.91	44.92	45.92	46.96	47.95	48.96
49.98	51.01	52.02	53.04	53.53	54.36
54.31	55.34	56.31	57.46	58.36	59.37
60.22	60.19	60.41	61.39	62.43	63.40
64.42	65.48	66.48	67.47	68.51	69.55
69.85	69.83	70.37	71.38	72.36	73.42

MM test 6

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.15	2.07	0.91	1.25	1.22	1.44
1.11	1.11	1.11	1.17	1.11	1.06
1.07	1.03	1.31	1.41	1.40	1.55
1.35	1.36	1.23	1.29	1.22	1.28
1.22	1.23	1.21	1.17	1.32	1.33
1.35	1.51	1.30	1.30	1.35	1.34
1.34	1.31	1.34	1.30	1.38	1.42
1.43	1.40	1.35	1.40	1.38	1.39
1.49	1.52	1.51	1.47	1.47	1.36
1.62	1.64	1.62	1.61	1.59	1.55
1.58	1.56	1.55	1.54	1.62	1.67
1.68	1.65	1.66	1.64	1.64	1.63
1.70	1.74	1.73	1.72	1.71	1.70
1.70	1.70	1.69	1.67	1.67	1.65
1.66	1.65	1.66	1.64	1.64	1.62

MEAN OF RMS= 1.47

TIME ON TARGET (SECS)

0.30	1.56	2.83	3.39	4.56	5.34
5.75	6.74	7.75	8.59	9.15	10.11
11.11	12.11	12.68	12.74	13.70	14.79
15.84	16.80	17.83	18.86	19.83	20.92
21.89	22.95	23.94	24.34	25.50	26.73
26.72	27.75	28.79	29.40	29.45	30.45
31.44	32.47	33.49	34.50	35.07	35.07
36.08	37.10	38.09	39.07	40.12	41.17
40.94	41.14	42.12	43.13	44.19	44.42
44.42	44.78	45.74	46.83	47.88	49.84
49.86	50.86	51.93	52.31	53.09	53.03
53.18	54.21	54.57	55.42	56.53	57.42
57.68	57.67	58.69	59.73	60.78	61.73
62.78	63.77	64.80	65.52	66.55	67.45
68.86	69.90	70.88	71.86	72.93	73.96

MM test 7

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.57	1.57	1.67	1.24	1.22	1.70
1.76	1.77	1.77	1.76	1.66	1.78
1.57	1.48	1.52	1.52	1.56	1.46
1.42	1.40	1.49	1.50	1.60	1.55
1.60	1.60	1.48	1.55	1.51	1.50
1.48	1.47	1.66	1.77	1.60	1.78
1.78	1.74	1.73	1.75	1.70	1.69
1.72	1.76	1.74	1.72	1.71	1.72
1.70	1.68	1.67	1.67	1.65	1.65
1.63	1.63	1.65	1.75	1.78	1.77
1.74	1.75	1.73	1.73	1.73	1.72
1.71	1.70	1.68	1.67	1.66	1.71
1.76	1.76	1.77	1.77	1.76	1.75
1.80	1.86	1.86	1.86	1.83	1.84
1.85	1.85	1.81	1.80	1.79	1.79

MEAN OF RMS= 1.68

TIME ON TARGET (SECS)

0.06	0.25	1.26	2.50	5.31	5.55
5.55	5.96	4.96	5.99	7.03	8.01
9.03	10.03	11.09	12.09	13.06	14.07
15.11	16.18	16.68	18.65	16.74	17.25
17.98	18.98	19.98	21.02	22.03	23.05
24.07	25.10	25.17	25.18	25.23	25.24
27.25	28.23	29.29	30.30	31.25	32.24
32.17	32.22	33.13	34.14	35.15	36.14
37.17	38.19	39.22	40.27	41.12	41.14
41.91	42.92	43.58	43.54	43.54	44.17
45.21	46.22	47.19	48.31	48.19	49.19
50.24	51.27	52.27	53.28	54.31	54.38
54.37	54.56	55.31	55.28	55.59	55.92
56.95	57.04	57.01	58.06	59.08	60.18
61.07	62.08	63.11	64.12	65.13	65.16

MM test 8

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.96	3.02	2.41	2.15	1.92	2.36
2.62	2.66	2.37	2.30	2.19	2.10
2.04	2.05	1.96	2.18	2.23	2.28
2.19	2.19	2.18	2.30	2.32	2.24
2.25	2.21	2.18	2.14	2.11	2.24
2.23	2.21	2.16	2.26	2.33	2.31
2.29	2.26	2.24	2.21	2.20	2.15
2.14	2.15	2.12	2.11	2.15	2.16
2.13	2.14	2.12	2.11	2.17	2.24
2.23	2.22	2.21	2.16	2.17	2.15
2.14	2.15	2.16	2.16	2.14	2.15
2.16	2.14	2.14	2.12	2.11	2.10
2.08	2.07	2.09	2.12	2.10	2.10
2.08	2.07	2.06	2.07	2.07	2.11
2.13	2.12	2.10	2.10	2.10	2.09

MEAN OF RMS= 2.16

TIME ON TARGET (SECS)

0.04	0.06	1.09	2.05	3.11	5.41
5.38	3.90	4.89	5.91	6.94	7.95
8.96	9.95	10.98	11.11	11.05	11.40
12.59	13.41	14.23	14.26	14.25	15.21
16.24	17.25	18.26	19.31	19.91	19.40
20.10	21.10	22.14	22.45	22.42	23.43
23.87	24.87	25.87	25.89	27.95	27.40
29.92	30.95	31.95	32.47	32.88	33.12
34.07	34.03	34.68	35.72	35.49	35.95
36.14	37.17	38.19	39.22	40.23	41.28
42.16	42.53	42.52	43.24	44.21	44.14
44.51	45.52	45.53	47.54	48.48	49.53
50.58	51.61	51.87	51.89	52.26	53.26
54.28	55.28	56.27	57.29	58.05	58.05
58.04	58.94	59.98	61.05	62.01	63.02

MM test 9

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.57	1.54	1.12	1.37	1.41	1.42
1.11	0.96	1.47	1.11	1.16	1.01
1.06	1.11	1.11	1.18	1.23	1.25
1.27	1.19	1.28	1.58	1.35	1.36
1.35.	1.54	1.45	1.54	1.46	1.49
1.43	1.46	1.53	1.58	1.57	1.56
1.57	1.54	1.52	1.52	1.50	1.50
1.47	1.45	1.47	1.45	1.53	1.53
1.52	1.51	1.55	1.49	1.48	1.49
1.58	1.56	1.55	1.55	1.56	1.55
1.52	1.54	1.52	1.53	1.51	1.50
1.50	1.49	1.47	1.50	1.49	1.49
1.49	1.47	1.48	1.47	1.48	1.44
1.45	1.43	1.44	1.42	1.43	1.43
1.57	1.58	1.59	1.55	1.55	1.55

MEAN OF RMS= 1.45

TIME ON TARGET (SECS)

0.98	1.98	3.03	4.04	5.05	6.04
7.05	8.08	9.11	9.56	9.99	10.49
12.04	13.06	14.05	15.09	16.09	16.36
16.61	17.63	18.10	18.29	19.28	20.30
21.33	22.37	22.72	22.72	23.64	24.64
25.68	26.68	27.18	27.19	28.08	29.08
30.12	31.07	32.12	33.15	34.17	35.15
36.14	37.22	38.20	39.19	39.28	41.32
40.55	41.56	42.63	43.56	44.62	45.42
45.38	46.07	47.07	48.08	49.09	50.09
51.14	51.79	52.08	53.07	54.08	55.07
56.03	57.09	58.12	58.29	59.31	61.14
60.95	61.46	62.95	63.97	64.95	65.45
67.02	68.02	69.06	70.02	71.10	71.52
71.56	72.15	72.96	73.26	74.98	76.47

MM test 10

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.57	1.37	1.29	1.56	1.22	1.20
1.10	1.04	1.23	1.26	1.38	1.24
1.19	1.22	1.21	1.18	1.14	1.29
1.22	1.29	1.39	1.52	1.23	1.30
1.60	1.57	1.58	1.55	1.55	1.50
1.50	1.48	1.46	1.44	1.41	1.42
1.41	1.38	1.44	1.44	1.43	1.45
1.41	1.44	1.43	1.43	1.41	1.39
1.40	1.39	1.38	1.39	1.39	1.37
1.38	1.37	1.37	1.34	1.35	1.34
1.32	1.32	1.38	1.45	1.42	1.41
1.41	1.40	1.41	1.39	1.39	1.36
1.37	1.39	1.41	1.41	1.42	1.41
1.40	1.40	1.39	1.42	1.40	1.40
1.44	1.48	1.49	1.49	1.49	1.48

MEAN OF RMS= 1.40

TIME ON TARGET (SECS)

0.41	0.70	1.71	2.74	3.75	4.80
5.75	6.81	6.98	7.24	8.23	9.25
10.30	11.26	12.30	13.28	13.33	14.41
15.36	15.64	16.05	17.09	18.13	19.25
19.86	19.89	20.92	21.93	22.97	23.43
24.97	25.98	26.96	27.99	29.00	30.03
31.03	32.03	32.33	32.70	33.90	34.94
35.94	36.39	37.12	38.09	39.14	40.12
41.13	42.19	43.15	44.18	45.21	46.16
47.26	48.25	49.25	50.26	51.32	52.31
53.32	54.33	54.59	54.59	54.64	55.43
56.87	57.88	58.91	59.89	60.91	61.90
62.92	63.92	63.61	64.43	65.43	66.92
67.52	68.50	69.55	70.50	70.62	71.58
72.58	72.87	73.55	74.43	75.43	76.42

MM test 11

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.94	1.76	1.12	1.57	1.52	1.44
1.63	1.96	1.88	1.92	1.86	1.41
1.77	1.68	1.67	1.62	1.64	1.77
1.78	1.72	1.68	1.64	1.65	1.62
1.58	1.58	1.57	1.55	1.82	1.58
1.68	1.65	1.85	1.80	1.86	1.79
1.77	1.75	1.75	1.71	1.70	1.74
1.66	1.66	1.64	1.65	1.63	1.69
1.61	1.59	1.58	1.57	1.55	1.56
1.54	1.60	1.63	1.63	1.65	1.62
1.72	1.76	1.76	1.74	1.74	1.75
1.74	1.78	1.77	1.76	1.75	1.74
1.75	1.72	1.70	1.70	1.69	1.68
1.73	1.80	1.81	1.78	1.80	1.77
1.80	1.79	1.79	1.79	1.79	1.78

MEAN OF RMS= 1.71

TIME ON TARGET (SECS)

0.41	1.41	2.46	3.45	4.31	5.45
5.86	5.89	6.65	7.05	8.37	7.85
8.66	9.68	10.69	11.71	12.74	13.79
13.31	14.34	15.36	16.36	17.36	18.38
19.36	20.40	21.46	22.42	23.52	24.47
25.37	24.38	24.53	25.37	25.34	27.38
28.43	29.40	30.48	31.44	32.46	33.43
34.47	35.52	36.52	37.52	38.57	39.57
40.59	41.61	42.63	43.61	44.61	45.58
46.66	47.08	47.07	47.56	48.52	49.53
49.73	49.77	49.93	50.93	51.93	52.92
53.44	53.58	54.54	55.63	56.65	57.67
58.63	59.68	60.68	61.65	62.76	63.75
64.43	64.42	64.42	65.11	66.10	66.10
66.72	67.77	68.75	69.53	69.55	70.58

MM test 12

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.96	2.57	1.88	1.77	1.87	1.70
1.83	1.42	1.46	1.26	1.95	1.67
2.09	2.10	2.01	1.98	1.92	1.94
1.85	1.82	1.78	1.72	1.76	1.75
1.69	1.63	1.69	1.75	1.75	1.75
1.67	1.66	1.66	1.71	1.66	1.77
1.76	1.75	1.75	1.71	1.70	1.77
1.67	1.66	1.64	1.61	1.66	1.60
1.65	1.67	1.66	1.64	1.65	1.68
1.61	1.60	1.59	1.59	1.57	1.56
1.55	1.56	1.55	1.55	1.55	1.51
1.61	1.60	1.60	1.58	1.58	1.60
1.56	1.58	1.56	1.57	1.55	1.56
1.65	1.64	1.64	1.63	1.63	1.63
1.60	1.59	1.60	1.60	1.59	1.58

MEAN OF RMS= 1.68

TIME ON TARGET (SECS)

6.06	0.96	1.94	2.99	4.03	5.03
6.01	7.04	8.03	9.06	8.45	9.45
9.91	10.21	11.20	12.24	13.29	14.28
15.30	16.29	17.30	18.35	19.34	20.35
21.36	22.33	23.40	23.35	24.94	25.93
25.97	26.98	27.98	28.97	29.97	30.94
30.36	31.38	32.42	33.42	34.42	35.42
36.45	37.49	38.48	39.50	40.50	41.52
41.48	42.34	43.38	44.36	45.41	46.43
47.44	48.42	49.42	50.49	51.45	52.53
53.47	54.52	55.56	56.22	56.21	56.22
56.78	57.46	58.46	59.47	60.47	61.52
62.52	63.57	64.56	65.58	66.56	66.42
66.86	67.57	68.57	69.58	70.56	71.51
72.63	73.66	74.66	75.65	76.58	77.71

MM test 13

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.08	1.57	1.12	1.24	1.51	1.[illegible]
1.73	1.67	1.67	1.45	1.43	1.43
1.41	1.59	1.54	1.[illegible]	1.[illegible]	1.[illegible]
1.65	1.59	1.51	1.[illegible]	1.64	1.[illegible]
1.52	1.60	1.63	1.[illegible]	1.55	1.[illegible]
1.63	1.59	1.58	1.60	1.58	1.58
1.59	1.57	1.53	1.[illegible]	1.54	1.[illegible]
1.60	1.60	1.61	1.[illegible]	1.5[illegible]	1.56
1.56	1.54	1.55	1.[illegible]	1.51	1.[illegible]
1.58	1.58	1.[illegible]	1.[illegible]	1.[illegible]	1.[illegible]
1.52	1.61	1.61	1.[illegible]	1.60	1.[illegible]
1.59	1.59	1.57	1.[illegible]	1.[illegible]	1.[illegible]
1.53	1.54	1.51	1.[illegible]	1.[illegible]	1.[illegible]
1.55	1.60	1.62	1.[illegible]	1.[illegible]	1.[illegible]
1.59	1.59	1.[illegible]	1.[illegible]	1.[illegible]	1.[illegible]

MEAN OF RMS= 1.56

TIME ON TARGET (SECS)

0.23	0.[illegible]	1.[illegible]	2.[illegible]	[illegible]	[illegible]
4.68	5.[illegible]	[illegible].94	7.90	[illegible].[illegible]	[illegible]
10.94	11.96	12.[illegible]	13.[illegible]	13.[illegible]	1[illegible]
15.46	16.48	17.13	17.54	1[illegible].[illegible]	1[illegible]
20.38	20.[illegible]	20.58	21.[illegible]	22.7[illegible]	[illegible]
25.[illegible]	24.53	25.[illegible]	26.[illegible]	27.[illegible]	[illegible]
28.74	29.76	30.75	31.84	32.82	[illegible]
34.04	34.49	35.4[illegible]	36.[illegible]	37.54	[illegible]
39.10	40.13	41.16	42.17	43.1[illegible]	[illegible]
43.59	44.62	45.64	46.[illegible]	47.6[illegible]	[illegible]
49.68	50.[illegible]	[illegible].[illegible]	51.[illegible]	[illegible].11	[illegible]
54.09	55.12	[illegible].12	57.13	[illegible].17	[illegible]
60.14	61.13	62.22	62.[illegible]	63.[illegible]	[illegible]
64.65	64.[illegible]	65.16	[illegible].[illegible]	67.[illegible]	[illegible]
69.20	70.16	71.17	72.20	73.1[illegible]	74.[illegible]

MM test 14

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

3.14	2.09	1.70	1.57	1.41	1.70
1.63	1.56	1.54	1.56	1.42	1.52
1.51	1.26	1.51	1.55	1.26	1.55
1.22	1.38	1.37	1.54	1.33	1.56
1.51.	1.27	1.25	1.29	1.36	1.22
1.24	1.24	1.27	1.25	1.34	1.40
1.47	1.47	1.47	1.47	1.42	1.44
1.42	1.44	1.40	1.41	1.37	1.39
1.40	1.39	1.38	1.38	1.38	1.38
1.50	1.51	1.52	1.49	1.49	1.49
1.47	1.45	1.44	1.45	1.43	1.45
1.43	1.42	1.43	1.41	1.40	1.43
1.39	1.41	1.38	1.39	1.40	1.43
1.43	1.41	1.41	1.42	1.43	1.40
1.41	1.40	1.38	1.38	1.40	1.41

MEAN OF RMS= 1.39

TIME ON TARGET (SECS)

0.06	1.01	2.04	3.05	4.03	4.45
5.51	6.48	7.55	7.86	8.59	9.61
10.65	11.66	12.68	13.71	14.71	15.75
16.74	16.78	17.73	18.74	19.75	20.75
21.75	22.79	23.88	24.84	25.85	26.85
27.78	27.79	28.72	29.72	30.27	31.31
31.38	32.35	33.38	34.43	35.41	36.42
37.49	38.47	39.47	40.46	41.51	42.16
42.67	43.63	44.54	44.87	45.35	45.46
47.12	47.43	48.41	49.45	50.42	51.44
52.48	53.46	54.53	55.52	56.54	57.56
58.58	59.59	60.63	61.62	62.67	63.65
64.68	65.68	66.66	67.72	68.67	69.65
68.88	69.92	70.92	71.95	72.93	73.93
74.98	75.98	77.01	78.03	78.12	78.66

RL test 1

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.58	1.93	3.75	3.42	3.26	3.15
2.84	3.11	2.91	2.75	2.70	2.66
2.48	2.42	2.34	2.28	2.18	2.20
2.14	2.19	2.15	2.10	2.09	2.02
2.01	2.00	1.94	2.06	2.15	2.10
2.09	2.05	1.99	2.00	2.06	2.05
2.02	2.00	1.97	1.96	1.98	1.93
1.89	1.90	1.88	1.85	1.84	1.85
1.81	1.81	1.79	1.78	1.74	1.75
1.73	1.72	1.71	1.70	1.77	1.72
1.79	1.78	1.77	1.85	1.89	1.86
1.87	1.85	1.84	1.83	1.82	1.81
1.80	1.80	1.79	1.78	1.78	1.78
1.79	1.78	1.76	1.75	1.75	1.74
1.73	1.77	1.77	1.76	1.75	1.75

MEAN OF RMS= 1.94

TIME ON TARGET (SECS)

0.00	0.41	0.43	0.86	0.86	1.31
2.46	2.40	3.11	4.19	5.19	6.20
7.20	8.25	9.21	10.25	11.24	12.31
13.18	13.16	13.70	14.71	15.71	16.18
17.25	18.25	19.25	19.65	19.85	20.87
21.89	22.87	23.38	24.34	25.37	26.34
25.58	27.62	28.59	29.65	30.67	31.70
32.70	33.72	34.73	35.69	36.74	37.75
38.74	39.80	40.78	41.84	42.86	43.84
44.92	45.93	46.91	47.92	48.25	49.43
49.46	50.47	51.52	52.16	52.14	52.46
54.01	55.06	56.08	57.04	58.08	59.11
60.13	61.17	62.13	63.13	64.18	65.18
65.25	66.05	67.07	68.05	69.11	70.12
71.07	71.58	71.92	72.71	73.65	74.61

RL test 2

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.15	1.76	0.91	1.24	1.11	1.10
1.19	1.24	0.90	0.95	1.16	1.11
0.97	1.11	0.86	0.88	0.85	0.87
1.05	1.38	1.37	1.38	1.16	1.32
1.61	1.61	1.62	1.55	1.55	1.54
1.57	1.55	1.53	1.50	1.51	1.45
1.44	1.46	1.52	1.53	1.51	1.52
1.61	1.59	1.57	1.57	1.60	1.58
1.57	1.55	1.55	1.53	1.54	1.55
1.52	1.52	1.50	1.52	1.49	1.49
1.47	1.45	1.45	1.46	1.45	1.45
1.42	1.41	1.42	1.41	1.40	1.40
1.41	1.38	1.36	1.37	1.42	1.40
1.43	1.44	1.42	1.42	1.41	1.44
1.49	1.48	1.47	1.47	1.45	1.45

MEAN OF RMSE 1.42

TIME ON TARGET (SECS)

0.09	1.14	2.16	3.19	4.19	5.21
6.25	7.26	8.25	9.29	10.30	11.23
12.30	13.34	14.36	15.36	16.41	17.45
18.28	18.35	19.95	19.76	20.75	21.32
21.85	22.10	22.40	23.45	24.47	25.28
25.64	26.72	27.77	28.79	29.78	30.79
31.80	32.85	33.20	33.73	34.72	35.73
36.72	37.75	38.77	39.85	39.79	40.79
41.82	42.86	43.88	44.94	45.88	46.92
46.97	48.01	49.03	50.15	51.06	52.07
53.12	54.12	55.12	56.15	57.21	58.19
59.16	60.17	61.24	62.22	63.27	64.30
65.31	66.31	67.31	68.36	69.32	70.33
70.35	71.35	72.37	73.41	74.43	75.05
75.31	76.32	77.32	78.33	79.35	80.18

RL test 3

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

0.00	1.94	1.70	1.57	1.49	1.43
1.32	1.30	1.45	1.15	1.54	1.52
1.37	1.29	1.46	1.57	1.57	1.53
1.48	1.51	1.41	1.47	1.44	1.50
1.50	1.47	1.51	1.56	1.51	1.53
1.57	1.54	1.51	1.50	1.51	1.43
1.46	1.45	1.44	1.42	1.41	1.40
1.41	1.41	1.41	1.41	1.41	1.39
1.41	1.41	1.40	1.39	1.39	1.38
1.35	1.40	1.44	1.39	1.41	1.38
1.38	1.44	1.42	1.45	1.42	1.41
1.42	1.42	1.39	1.40	1.39	1.37
1.39	1.41	1.39	1.39	1.38	1.39
1.38	1.37	1.40	1.40	1.36	1.38
1.36	1.36	1.36	1.39	1.37	1.40

MEAN OF RMS= 1.42

TIME ON TARGET (SEC)

0.99	1.60	2.26	3.23	4.30	5.25
6.31	7.35	8.39	9.38	10.06	11.14
11.61	12.58	13.33	13.74	14.71	15.73
16.80	17.28	18.24	19.23	20.26	20.63
21.67	22.64	23.53	23.70	24.04	25.09
26.08	27.10	28.12	29.14	30.17	31.18
32.19	33.18	34.22	35.20	36.25	37.24
38.22	39.29	39.68	40.65	41.71	42.72
42.99	43.66	44.63	45.71	46.71	47.72
48.76	49.09	50.01	50.97	52.06	53.02
54.03	54.19	55.22	56.24	57.26	58.29
58.83	59.83	60.68	61.90	62.90	63.93
64.46	65.25	66.27	67.26	68.28	69.31
70.21	71.31	71.75	72.70	73.72	74.76
75.76	76.77	77.77	78.25	79.06	80.12

RL test 4

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

3.76	3.79	3.26	2.69	2.59	2.44
2.22	2.11	2.03	2.02	1.96	1.89
1.92	1.83	1.79	1.84	1.84	1.83
1.90	1.87	1.80	1.80	1.79	1.75
1.70	1.68	1.72	1.70	1.66	1.62
1.63	1.59	1.59	1.59	1.58	1.57
1.58	1.60	1.60	1.60	1.59	1.55
1.56	1.59	1.53	1.52	1.56	1.51
1.50	1.48	1.46	1.47	1.53	1.52
1.51	1.50	1.53	1.56	1.57	1.55
1.54	1.54	1.54	1.52	1.50	1.52
1.50	1.52	1.49	1.49	1.48	1.49
1.51	1.50	1.53	1.50	1.50	1.56
1.55	1.54	1.54	1.54	1.53	1.53
1.55	1.54	1.53	1.58	1.57	1.58

MEAN OF RMS= 1.61

TIME ON TARGET (SECS)

0.09	0.05	0.96	1.98	3.01	4.02
5.01	6.03	7.06	7.83	8.38	9.41
10.45	11.41	12.38	12.88	13.86	14.89
14.30	15.33	16.34	17.35	18.33	19.40
20.38	20.73	21.74	22.70	23.73	24.75
25.80	26.83	27.82	28.25	29.32	30.30
31.15	31.24	32.07	33.10	34.10	35.12
36.12	37.15	38.17	39.22	40.23	41.28
42.26	43.26	44.23	45.24	46.47	46.47
47.48	48.49	49.22	49.42	50.33	51.36
52.37	53.39	54.38	55.42	56.43	57.47
58.46	58.81	59.82	60.84	61.85	62.70
62.90	63.88	64.90	65.91	66.45	67.17
67.81	68.71	69.77	70.80	71.77	72.96
73.95	73.98	74.96	75.33	75.81	76.97

RL test 5

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

3.38	4.26	3.76	3.24	2.90	2.76
2.41	2.42	2.19	2.19	2.12	2.08
2.13	2.08	1.98	2.04	1.98	1.87
1.82	1.81	1.79	1.79	1.77	1.80
1.80	1.75	1.75	1.72	1.66	1.69
1.68	1.66	1.65	1.66	1.70	1.69
1.64	1.64	1.63	1.71	1.70	1.65
1.67	1.62	1.64	1.60	1.64	1.70
1.66	1.67	1.66	1.65	1.66	1.65
1.62	1.62	1.60	1.59	1.57	1.57
1.57	1.77	1.79	1.81	1.82	1.78
1.82	1.80	1.80	1.79	1.77	1.76
1.77	1.78	1.76	1.76	1.76	1.75
1.74	1.73	1.75	1.73	1.73	1.74
1.75	1.78	1.78	1.76	1.76	1.76

MEAN OF RMS= 1.75

TIME ON TARGET (SECS)

0.00	0.01	0.39	1.41	2.46	3.44
4.46	5.53	6.06	6.95	7.98	8.74
9.04	9.96	11.00	12.01	13.00	14.02
15.09	16.08	17.11	18.05	18.86	19.88
20.01	20.94	21.93	22.93	23.94	24.94
25.14	26.14	27.22	28.04	28.50	29.53
30.40	31.37	32.44	32.95	33.50	34.42
35.53	36.57	37.60	38.62	39.50	40.65
40.64	41.64	42.63	43.58	44.67	45.72
46.72	47.07	48.11	49.16	50.11	51.11
52.14	52.41	52.68	53.89	54.37	55.39
55.88	56.89	57.91	58.42	59.36	60.34
61.62	62.13	63.16	64.21	65.25	66.21
67.18	68.25	69.22	69.58	70.55	71.41
72.50	72.45	73.45	74.47	75.47	76.45

RL test 6

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

3.56	4.24	3.60	3.09	2.77	2.65
2.37	2.25	2.28	2.2[illegible]	1.9[illegible]	1.97
1.99	2.03	1.84	1.86	1.8[illegible]	1.91
1.73	1.72	1.71	1.74	1.72	1.76
1.64	1.71	1.67	1.[illegible]	1.66	1.71
1.59	1.57	1.60	1.61	1.63	1.56
1.56	1.61	1.66	1.[illegible]3	1.61	1.60
1.60	1.59	1.57	1.56	1.54	1.52
1.55	1.54	1.54	1.[illegible]5	1.[illegible]2	1.[illegible]5
1.53	1.50	1.50	1.50	1.[illegible]5	1.[illegible]5
1.53	1.53	1.52	1.51	1.51	1.49
1.48	1.48	1.47	1.46	1.4[illegible]	1.47
1.44	1.49	1.50	1.4[illegible]	1.4[illegible]	1.[illegible]0
1.49	1.48	1.4[illegible]	1.4[illegible]	1.47	1.45
1.45	1.45	1.44	1.4[illegible]	1.4[illegible]	1.47

MEAN OF RMS= 1.59

TIME ON TARGET (SECS)

0.03	0.06	0.94	1.95	2.93	4.01
4.96	5.95	6.58	7.59	8.60	[illegible].59
10.03	10.75	11.76	12.81	13.78	14.[illegible]3
15.79	16.79	17.89	18.85	19.13	20.15
21.17	21.94	22.42	23.44	24.45	2[illegible].45
26.52	27.50	27.98	28.82	29.62	30.70
31.69	32.49	32.89	33.90	34.7[illegible]	3[illegible].[illegible]
35.88	37.45	38.45	39.[illegible]2	40.4[illegible]	41.4[illegible]
42.52	43.52	44.24	44.73	45.74	4[illegible].[illegible]2
47.81	48.87	49.87	50.83	51.13	[illegible]2.08
53.07	54.12	55.11	56.13	57.13	[illegible]8.16
59.21	60.18	61.23	62.[illegible]3	63.22	64.23
65.28	66.87	66.33	67.40	68.35	[illegible].[illegible]5
70.37	71.42	72.38	73.40	74.47	7[illegible].47
76.48	77.50	78.55	79.53	80.53	[illegible].07

RL test 7

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.01	1.11	2.03	1.57	1.[illegible]	[illegible].03
2.01	2.01	1.99	1.[illegible]6	1.86	1.[illegible]4
2.04	1.97	1.90	1.[illegible]0	1.84	1.79
1.94	2.00	1.92	1.[illegible]8	1.85	1.[illegible]0
1.80	1.78	1.77	1.75	1.71	1.71
1.73	1.82	1.84	1.[illegible]4	1.[illegible]2	1.[illegible]3
1.92	1.91	1.90	1.[illegible]8	1.8[illegible]	1.[illegible]6
1.64	1.88	1.86	1.[illegible]6	1.8[illegible]	1.[illegible]5
1.86	1.87	1.86	1.[illegible]4	1.[illegible]5	1.[illegible]2
1.81	1.83	1.83	1.[illegible]3	1.82	1.[illegible]0
1.78	1.79	1.77	1.75	1.7[illegible]	1.79
1.79	1.78	1.77	1.7[illegible]	1.7[illegible]	1.75
1.74	1.73	1.77	1.79	1.78	1.75
1.75	1.74	1.73	1.73	1.73	1.73
1.71	1.70	1.69	1.72	1.73	1.79

MEAN OF RMS= 1.81

TIME ON TARGET (SECS)

0.04	0.06	1.10	2.11	2.41	2.45
5.50	4.30	4.[illegible]	5.[illegible]5	[illegible].28	7.[illegible]3
7.03	7.73	8.78	9.[illegible]3	10.31	11. 1
11.91	12.16	13.18	14.19	1[illegible].[illegible]3	1[illegible].18
17.21	18.28	19.23	20.2[illegible]	21.24	[illegible].32
23.24	23.18	23.50	24.23	2[illegible].25	[illegible].7
26.35	26.37	27.38	28.39	29.82	[illegible].[illegible]3
31.64	31.68	32.23	33.27	34.2[illegible]	[illegible].[illegible]6
35.59	35.69	36.74	37.75	38.7[illegible]	[illegible].77
40.82	40.99	41.26	42.26	43.28	[illegible].[illegible]8
45.33	46.33	47.36	48.3[illegible]	4[illegible].42	[illegible].57
49.81	50.78	51.82	52.82	53.82	[illegible].[illegible]9
55.66	56.71	56.54	57.13	58.1[illegible]	[illegible].17
60.27	61.22	62.26	63.28	64.2[illegible]	[illegible].30
66.32	67.30	68.31	68.93	69.9[illegible]	[illegible].35

RL test 8

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.61	1.11	0.91	2.16	2.11	2.05
1.93	1.84	1.77	1.68	1.70	1.70
1.82	1.73	1.77	1.71	1.70	1.68
1.65	1.59	1.63	1.67	1.78	1.66
1.66	1.64	1.63	1.60	1.61	1.76
1.57	1.58	1.58	1.65	1.66	1.61
1.61	1.59	1.59	1.66	1.67	1.67
1.67	1.65	1.63	1.61	1.69	1.68
1.59	1.58	1.58	1.65	1.64	1.64
1.73	1.77	1.74	1.74	1.74	1.74
1.72	1.71	1.71	1.72	1.74	1.72
1.72	1.76	1.75	1.75	1.73	1.77
1.76	1.74	1.75	1.74	1.72	1.73
1.70	1.72	1.74	1.74	1.72	1.72
1.71	1.71	1.71	1.70	1.69	1.68

MEAN OF RMS= 1.68

TIME ON TARGET (SECS)

0.34	1.46	2.38	2.76	3.63	4.18
5.18	5.60	6.63	7.63	8.40	9.48
9.45	10.43	11.30	12.46	13.46	14.49
15.56	16.54	17.56	18.20	19.36	20.34
20.39	21.40	22.40	23.42	24.43	25.47
26.45	26.63	27.39	28.45	29.19	30.13
30.18	31.14	32.22	33.22	34.20	35.25
34.19	35.22	36.12	37.12	38.15	39.13
40.17	41.18	42.19	43.18	44.24	45.24
45.22	45.71	46.71	47.71	48.53	49.53
49.73	50.74	51.52	51.52	52.52	53.56
53.21	54.27	55.29	56.13	56.18	57.14
58.16	59.22	60.19	61.19	62.26	63.26
64.23	64.96	65.10	66.10	67.07	68.03
69.17	70.17	71.17	72.18	73.26	74.32

RL test 9

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.96	2.09	1.29	1.47	1.31	1.11
1.03	1.24	1.23	1.31	1.08	1.14
1.19	1.68	1.65	1.57	1.57	1.52
1.48	1.51	1.71	1.67	1.64	1.62
1.62	1.58	1.57	1.58	1.54	1.50
1.49	1.54	1.53	1.56	1.51	1.50
1.48	1.47	1.46	1.46	1.46	1.46
1.49	1.47	1.46	1.53	1.53	1.51
1.50	1.50	1.53	1.52	1.52	1.50
1.50	1.50	1.50	1.49	1.48	1.46
1.47	1.46	1.45	1.46	1.45	1.46
1.47	1.47	1.46	1.46	1.46	1.42
1.57	1.57	1.56	1.56	1.57	1.56
1.55	1.54	1.54	1.54	1.52	1.53
1.51	1.50	1.50	1.50	1.50	1.51

MEAN OF RMS= 1.50

TIME ON TARGET (SECS)

0.01	0.36	1.39	2.41	3.41	4.41
5.41	6.48	8.89	7.71	8.71	9.71
10.74	10.79	11.13	11.89	13.00	14.01
15.06	16.03	16.01	17.05	18.06	19.03
20.06	21.08	22.12	22.54	23.52	24.59
25.33	26.79	26.82	27.30	28.37	29.43
30.87	31.92	32.94	33.99	34.97	35.98
36.05	37.07	38.08	38.14	39.08	40.02
41.03	42.07	42.47	43.12	44.13	44.78
46.46	46.48	47.49	48.49	49.49	50.49
50.84	51.89	52.92	53.93	54.61	55.62
56.02	56.97	58.01	59.05	60.02	61.04
60.87	61.90	62.46	63.12	64.12	65.13
66.18	67.17	68.21	69.27	70.26	71.27
72.26	73.30	74.28	75.32	76.33	77.30

RL test 10

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.91	3.45	2.87	2.87	2.23	2.87
2.06	1.80	1.73	1.75	1.64	1.[illegible]
1.57	1.57	1.52	1.49	1.52	1.46
1.57	1.55	1.51	1.48	1.50	1.41
1.44	1.41	1.35	1.38	1.35	1.36
1.39	1.36	1.31	1.40	1.39	1.40
1.38	1.40	1.41	1.39	1.33	1.41
1.39	1.36	1.33	1.34	1.36	1.33
1.33	1.30	1.31	1.29	1.31	1.42
1.41	1.41	1.39	1.38	1.47	1.46
1.46	1.44	1.45	1.43	1.45	1.48
1.49	1.46	1.47	1.45	1.45	1.47
1.46	1.46	1.45	1.45	1.43	1.45
1.44	1.43	1.45	1.46	1.45	1.44
1.44	1.43	1.42	1.43	1.44	1.47

MEAN OF RMS= 1.43

TIME ON TARGET (SECS)

0.05	0.48	1.10	2.11	3.13	[illegible]
5.18	6.18	7.24	8.24	9.21	10.[illegible]
11.28	12.33	13.31	14.36	15.03	16.21
16.08	17.05	18.03	19.09	20.11	21.19
22.12	23.12	24.19	25.13	26.19	[illegible]
27.04	28.07	29.09	[illegible]	32.[illegible]	[illegible]
32.90	33.52	34.53	35.53	36.54	37.[illegible]
38.56	39.59	40.63	41.67	42.56	[illegible]
44.09	45.72	46.76	47.76	48.71	[illegible]
49.09	50.92	51.94	52.97	53.57	[illegible]
55.23	56.28	57.33	58.34	[illegible]	[illegible]
60.72	61.72	62.78	63.72	64.76	[illegible]
66.12	67.20	68.22	[illegible]	70.21	71.[illegible]
72.26	73.27	73.[illegible]	74.50	75.55	[illegible]
77.20	78.20	79.22	80.23	81.43	[illegible]

RL test 11

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

3.54	2.64	3.51	2.[illegible]	2.66	[illegible]
2.22	2.15	1.42	1.[illegible]	1.[illegible]	1.[illegible]
2.02	1.97	1.96	1.96	1.86	1.[illegible]
1.78	1.75	1.69	1.72	1.70	[illegible]
1.65	1.66	1.63	1.60	1.60	1.[illegible]
1.57	1.56	1.54	1.[illegible]	1.[illegible]	1.[illegible]
1.46	1.55	1.[illegible]	1.[illegible]	1.[illegible]	1.[illegible]
1.47	1.51	1.[illegible]	1.47	1.47	1.49
1.55	1.54	1.[illegible]	1.[illegible]	1.51	1.[illegible]
1.49	1.49	1.49	1.[illegible]	1.47	1.[illegible]
1.48	1.48	1.47	1.[illegible]	1.[illegible]	1.44
1.43	1.44	1.[illegible]	1.42	1.41	1.41
1.41	1.41	1.40	1.[illegible]	1.[illegible]	1.[illegible]
1.37	1.37	1.37	1.[illegible]	1.[illegible]	1.[illegible]
1.37	1.37	1.37	1.[illegible]	1.37	1.[illegible]

MEAN OF RMS= 1.54

TIME ON TARGET (SECS)

0.20	1.21	1.46	2.[illegible]	3.[illegible]	[illegible]
5.56	6.58	7.56	8.[illegible]	9.61	10.[illegible]
11.01	11.78	12.76	13.74	14.81	1[illegible]
16.18	17.23	18.20	19.28	20.26	2[illegible]
21.60	22.65	23.[illegible]	24.[illegible]	2[illegible]	[illegible]
27.54	28.24	29.20	30.27	31.25	[illegible]
33.29	35.63	34.[illegible]	35.[illegible]	3[illegible]	3[illegible]
38.72	39.68	40.[illegible]	41.73	42.[illegible]	4[illegible]
43.93	44.[illegible]	46.01	47.02	47.[illegible]	[illegible]
50.04	51.07	52.[illegible]	53.[illegible]	54.12	[illegible]
55.41	56.44	57.43	58.48	5[illegible]	[illegible]
61.51	62.55	63.55	64.[illegible]	65.57	[illegible]
67.58	68.61	69.65	70.66	71.70	[illegible]
73.73	74.72	75.75	76.[illegible]	77.[illegible]	[illegible]
78.97	80.00	81.06	82.07	83.08	[illegible]

RL test 12

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.94	1.76	1.70	1.57	1.57	1.51
1.45	1.24	1.29	1.36	1.30	1.34
1.19	1.32	0.99	1.27	1.19	1.11
1.11	1.14	1.16	1.11	1.11	1.11
1.25	1.31	1.36	1.31	1.27	1.30
1.24	1.29	1.27	1.22	1.30	1.31
1.29	1.26	1.26	1.26	1.27	1.27
1.25	1.32	1.39	1.42	1.34	1.36
1.36	1.39	1.31	1.34	1.35	1.33
1.35	1.32	1.31	1.29	1.31	1.34
1.35	1.34	1.32	1.31	1.32	1.34
1.31	1.36	1.31	1.35	1.31	1.35
1.32	1.33	1.31	1.30	1.28	1.30
1.29	1.30	1.28	1.41	1.31	1.30
1.31	1.32	1.31	1.30	1.30	1.29

MEAN OF RMS= 1.28

TIME ON TARGET (SEC)

0.01	0.48	1.53	2.53	3.53	4.24
5.54	6.59	7.60	8.53	9.51	10.55
11.63	12.61	13.58	14.76	15.69	16.71
17.74	18.76	19.76	20.78	21.67	22.78
23.23	23.66	24.94	25.95	27.37	27.95
28.97	30.00	31.05	31.99	33.57	34.58
34.40	35.39	36.44	37.43	38.43	39.48
40.45	41.24	41.61	42.62	43.64	44.65
45.63	46.71	47.68	48.72	49.75	50.79
51.77	52.77	53.81	54.91	55.89	56.92
57.07	58.09	59.08	60.14	61.12	62.15
63.13	64.16	64.66	65.53	66.53	67.56
68.57	69.57	70.60	71.62	72.63	73.63
74.47	75.50	76.47	76.66	77.47	78.50
79.23	80.21	81.22	82.23	83.22	84.24

RL test 13

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.60	1.94	1.20	0.97	1.60	1.61
1.05	1.04	0.90	0.99	1.02	1.01
1.07	1.05	0.95	0.90	1.34	1.31
1.17	1.55	1.41	1.39	1.57	1.54
1.55	1.29	1.50	1.45	1.40	1.47
1.57	1.57	1.54	1.55	1.55	1.52
1.54	1.52	1.48	1.42	1.43	1.44
1.42	1.41	1.36	1.35	1.50	1.51
1.56	1.39	1.51	1.55	1.57	1.57
1.56	1.57	1.55	1.54	1.54	1.55
1.53	1.51	1.55	1.54	1.54	1.57
1.52	1.52	1.52	1.51	1.52	1.50
1.50	1.51	1.52	1.50	1.51	1.50
1.51	1.50	1.50	1.50	1.50	1.57
1.56	1.56	1.54	1.54	1.52	1.55

MEAN OF RMS= 1.51

TIME ON TARGET (SEC.)

0.26	1.50	2.26	5.29	9.50	9.[illegible]
6.34	7.40	8.56	9.59	10.43	11.45
12.46	13.45	14.49	15.43	15.42	[illegible]
13.26	16.50	17.30	20.05	20.57	[illegible]
22.38	25.02	24.90	25.50	25.34	[illegible]
28.12	29.12	30.14	31.13	32.13	[illegible]
34.20	35.27	35.38	36.37	37.37	[illegible]
39.45	40.42	41.44	42.48	43.47	[illegible]
45.51	45.51	46.31	47.31	48.37	[illegible]
50.54	51.56	53.02	54.01	55.01	[illegible]
57.05	58.03	59.06	59.56	60.56	[illegible]
62.36	63.33	64.42	65.43	66.43	[illegible]
68.46	69.50	70.45	70.59	71.53	[illegible]
73.55	74.51	75.55	76.56	77.57	[illegible]
78.67	79.70	80.67	81.68	82.71	[illegible]

RL test 14

ROLL
STEP FUNCTION

RMS VALUE OF [illegible]

1.60	1.57	1.11	1.57	1.11	1.[illegible]0
1.19	1.04	1.05	1.[illegible]5	1.5[illegible]	1.[illegible]
1.24	1.56	1.61	1.56	1.47	1.56
1.42	1.43	1.57	1.5[illegible]	1.43	1.41
1.55	1.56	1.55	1.55	1.55	1.51
1.29	1.53	1.52	1.26	1.29	1.[illegible]7
1.26	1.25	1.2[illegible]	1.20	1.2[illegible]	1.50
1.18	1.21	1.[illegible]5	1.[illegible]9	1.30	1.[illegible]9
1.29	1.28	1.27	1.28	1.2[illegible]	1.[illegible]8
1.29	1.29	1.27	1.[illegible]4	1.27	1.27
1.29	1.27	1.[illegible]6	1.[illegible]5	1.2[illegible]	1.[illegible]4
1.26	1.25	1.27	1.[illegible]5	1.[illegible]2	1.[illegible]7
1.30	1.29	1.[illegible]9	1.[illegible]6	1.[illegible]4	1.[illegible]5
1.33	1.32	1.32	1.31	1.3[illegible]	1.[illegible]2
1.34	1.34	1.36	1.34	1.34	1.[illegible]

MEAN OF RMS= 1.31

TIME OF TARGET (SECS)

0.45	1.48	2.48	3.46	[illegible].[illegible]1	[illegible].[illegible]3
6.51	7.53	8.49	9.14	[illegible].[illegible]3	10.[illegible]
11.89	12.93	13.96	14.66	15.[illegible]1	1[illegible].23
17.29	18.26	19.51	20.55	20.[illegible]5	[illegible].[illegible]
22.65	23.64	24.64	25.72	2[illegible].7[illegible]	[illegible].[illegible]
28.70	29.75	30.75	31.75	32.77	[illegible].77
34.80	35.82	36.85	37.80	3[illegible].8[illegible]	3[illegible].[illegible]
40.86	41.84	42.92	43.89	4[illegible].9[illegible]	[illegible].[illegible]
45.52	46.25	47.85	48.53	4[illegible].51	[illegible].77
50.59	51.74	52.71	53.74	5[illegible].7[illegible]	.7[illegible]
56.79	57.61	58.73	59.89	60.37	[illegible].[illegible]
62.17	63.22	64.17	65.17	66.20	[illegible].[illegible]
67.31	68.55	69.58	70.58	71.65	[illegible].[illegible]
73.03	73.96	74.98	75.96	76.95	[illegible].[illegible]
78.01	79.32	80.35	81.36	82.35	[illegible].[illegible]

SF test 1

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.55	1.56	[illegible]	1.55	1.52	[illegible]
1.11	1.71	1.57	1.72	1.61	[illegible]
1.57	1.49	1.47	1.47	1.55	[illegible]
1.33	1.29	1.35	1.69	2.06	[illegible]
2.11	2.16	2.16	2.13	2.10	[illegible]
2.06	1.97	1.99	1.96	1.93	[illegible]
1.90	1.88	1.85	1.86	1.91	[illegible]
1.90	1.91	1.95	1.94	1.91	[illegible]
1.87	1.88	1.86	1.84	1.82	[illegible]
1.80	1.79	1.78	1.79	1.82	[illegible]
1.86	1.85	1.83	1.90	1.92	[illegible]
1.88	1.88	1.87	1.86	1.86	[illegible]
1.84	1.82	1.82	1.81	1.80	[illegible]
1.84	1.92	1.94	1.93	1.92	[illegible]
2.00	2.02	2.01	1.99	1.99	[illegible]

MEAN OF RMS= 1.85

TIME ON TARGET (SECS)

0.05	1.03	2.05	3.10	4.11	[illegible]
6.11	6.54	8.84	7.16	8.14	[illegible]
10.21	11.19	12.23	13.19	14.30	[illegible]
16.31	17.31	18.29	19.35	20.30	[illegible]
22.28	23.33	24.08	25.10	26.10	[illegible]
28.14	29.19	30.17	31.23	32.19	[illegible]
34.22	35.25	36.25	37.17	38.13	[illegible]
40.60	41.04	41.35	42.37	43.38	[illegible]
45.40	46.42	47.44	48.44	49.44	[illegible]
51.49	52.53	53.52	54.53	55.81	[illegible]
57.81	58.85	59.87	60.91	61.14	[illegible]
64.12	65.14	65.47	66.43	67.52	[illegible]
69.53	70.08	70.83	71.51	72.80	[illegible]
74.11	74.15	74.06	74.58	75.62	[illegible]
76.43	76.91	77.48	78.35	79.31	[illegible]

SF test 2

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.74	2.10	1.93	2.58	2.44	1.56
2.19	2.08	1.49	1.86	2.09	1.98
1.93	1.90	1.81	1.82	1.96	1.87
1.82	1.78	1.72	1.75	1.72	1.71
1.68	1.66	1.63	1.77	1.64	1.61
1.76	1.74	1.75	1.72	1.69	1.77
1.77	1.75	1.74	1.70	1.69	1.67
1.67	1.66	1.65	1.62	1.65	1.64
1.62	1.62	1.61	1.60	1.56	1.57
1.57	1.57	1.54	1.57	1.57	1.56
1.60	1.60	1.57	1.58	1.57	1.56
1.61	1.60	1.58	1.59	1.53	1.57
1.56	1.63	1.66	1.65	1.64	1.64
1.63	1.62	1.62	1.61	1.61	1.66
1.58	1.58	1.57	1.62	1.70	1.70

MEAN OF RMS= 1.68

TIME ON TARGET (SECS)

0.06	0.48	1.46	1.98	2.29	3.25
4.30	5.29	6.36	7.34	7.55	9.15
9.14	10.16	11.18	12.23	12.41	13.43
14.05	15.03	16.01	17.08	18.05	19.08
20.06	20.98	22.12	22.42	22.64	24.54
24.87	25.88	26.87	27.88	28.93	29.43
30.05	31.02	32.07	33.09	34.07	35.12
36.12	37.10	38.17	39.15	39.35	40.32
41.28	42.33	43.34	44.38	45.41	46.43
47.43	48.42	49.32	43.33	50.32	51.34
51.62	52.57	53.36	54.37	55.42	56.41
56.51	57.54	58.54	59.46	59.82	60.38
61.95	62.28	62.47	63.38	64.08	65.12
66.15	67.15	68.17	69.13	70.20	71.19
72.18	73.23	74.25	74.98	75.13	75.21

SF test 3

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.94	1.11	1.[illegible]	0.79	0.86	1.[illegible]1
1.19	1.89	2.14	2.05	1.99	1.[illegible]7
2.00	1.91	1.82	1.[illegible]2	1.91	1.[illegible]3
1.87	1.96	2.10	2.01	1.99	1.[illegible]
1.94	2.03	2.03	1.99	1.98	1.[illegible]
1.95	1.91	1.97	1.97	1.94	1.[illegible]
1.96	1.93	1.94	1.93	1.89	1.[illegible]
1.93	1.91	1.91	2.01	2.03	2.00
1.98	1.96	1.96	1.94	1.92	[illegible]
2.08	2.06	2.05	2.04	2.03	2.02
2.02	2.00	1.99	2.00	1.99	2.[illegible]0
1.99	1.97	1.95	1.95	1.92	1.[illegible]1
1.91	1.91	1.92	1.90	1.89	1.[illegible]9
1.88	1.87	1.85	1.85	1.84	1.[illegible]1
1.83	1.82	1.81	1.[illegible]0	1.80	1.[illegible]

MEAN OF RMS= 1.94

TIME ON TARGET (SECS)

0.28	1.29	2.31	3.34	4.34	[illegible]
6.41	6.85	7.08	8.09	9.06	[illegible]
9.85	10.85	11.88	12.91	13.26	1[illegible]
14.64	15.54	15.58	16.45	17.45	1[illegible]
19.48	19.71	20.40	21.39	22.45	23.[illegible]
24.47	25.37	25.54	26.43	27.40	2[illegible]
28.47	29.56	30.52	31.52	32.52	3[illegible]
33.56	34.60	35.29	35.25	35.77	36.[illegible]
37.08	38.05	39.07	40.09	41.09	41.[illegible]
41.88	42.91	43.62	44.56	45.59	45.[illegible]
46.19	47.21	48.22	49.26	49.96	[illegible]
51.33	52.34	53.34	54.37	55.41	[illegible]
57.39	58.42	58.54	59.39	60.42	61.42
62.49	63.46	64.48	65.52	66.51	67.[illegible]1
68.55	69.58	70.56	71.60	72.61	73.[illegible]

SF test 4

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.79	1.76	1.70	1.47	1.56	1.[illegible]
1.11	1.76	2.03	1.33	2.01	2.01
1.95	1.55	2.09	2.10	2.04	1.28
1.96	1.96	1.91	1.58	1.84	1.91
1.89	1.81	1.80	1.80	1.79	1.75
1.73	1.73	1.71	1.68	1.65	1.[illegible]
1.65	1.65	1.61	1.64	1.62	1.[illegible]
1.60	1.52	1.57	1.56	1.55	1.[illegible]
1.52	1.51	1.51	1.49	1.55	1.[illegible]
1.62	1.61	1.67	1.66	1.63	1.64
1.62	1.62	1.62	1.61	1.60	1.60
1.58	1.58	1.56	1.56	1.58	1.[illegible]
1.58	1.56	1.57	1.57	1.55	1.[illegible]
1.58	1.56	1.57	1.56	1.55	1.54
1.55	1.54	1.54	1.[illegible]	1.52	1.[illegible]

MEAN OF RMS= 1.67

TIME ON TARGET (SECS)

0.15	0.66	1.00	2.01	3.03	4.03
5.05	5.70	6.93	6.65	6.58	7.[illegible]
8.11	9.13	9.46	9.85	10.91	11.[illegible]
12.38	13.04	13.51	14.55	15.56	15.[illegible]
16.53	17.61	18.61	19.68	20.65	21.70
22.72	23.67	24.72	25.77	26.75	27.75
28.82	29.79	30.55	31.12	32.13	33.[illegible]
34.15	35.18	36.23	37.22	38.23	39.[illegible]
40.27	41.32	42.29	43.33	43.93	44.[illegible]
45.27	46.27	46.49	47.23	48.23	49.[illegible]
50.27	51.31	52.31	53.33	54.34	55.[illegible]
56.36	57.19	58.18	58.73	59.26	59.[illegible]
60.86	61.92	62.91	63.45	63.00	65.42
66.20	67.25	68.30	69.27	70.32	71.[illegible]
72.33	73.33	74.37	75.37	76.41	77.43

SF test 5

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

3.13	1.37	1.72	1.37	2.12	1.93
1.84	1.47	1.70	1.66	1.61	1.64
1.60	1.65	1.63	1.47	1.59	1.56
1.49	1.45	1.46	1.40	1.45	1.44
1.35	1.34	1.34	1.30	1.29	1.30
1.29	1.27	1.28	1.28	1.26	1.27
1.48	1.45	1.46	1.45	1.45	1.42
1.41	1.51	1.58	1.57	1.57	1.56
1.56	1.56	1.53	1.52	1.52	1.52
1.53	1.62	1.63	1.61	1.60	1.61
1.59	1.58	1.67	1.67	1.67	1.66
1.65	1.65	1.64	1.63	1.59	1.61
1.62	1.60	1.60	1.59	1.59	1.57
1.57	1.55	1.56	1.54	1.54	1.53
1.57	1.59	1.58	1.58	1.58	1.57

MEAN OF RMS= 1.52

TIME ON TARGET (SECS)

0.06	1.06	2.06	3.10	5.06	4.08
5.04	6.01	7.01	8.03	9.01	9.96
10.01	11.03	12.08	13.11	14.08	15.13
16.13	17.11	18.14	19.20	20.20	21.14
22.25	23.22	23.79	24.97	25.59	26.52
27.56	28.57	29.63	30.54	31.70	31.97
32.53	33.58	34.59	35.54	36.62	37.52
38.60	39.14	39.27	40.52	41.31	42.33
43.32	44.31	45.33	46.34	47.36	48.42
49.23	49.23	50.21	51.32	52.22	53.27
54.27	55.26	55.23	56.02	56.96	57.81
58.99	60.03	61.08	62.11	63.16	64.20
65.13	66.13	67.17	68.20	69.20	70.13
71.18	72.22	73.26	74.26	75.28	76.27
76.72	77.12	78.07	78.08	79.12	80.13

SF test 6

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.13	1.11	2.04	2.30	2.00	1.[illegible]
1.73	1.67	1.[illegible]	1.53	1.46	1.[illegible]
1.45	1.68	1.67	1.54	1.64	1.[illegible]
1.47	1.55	1.57	1.74	1.87	1.[illegible]
1.75	1.76	1.75	1.72	1.70	1.[illegible]
1.65	1.64	1.62	1.61	1.62	1.[illegible]
1.61	1.63	1.57	1.56	1.55	1.[illegible]
1.52	1.51	1.50	1.48	1.47	1.[illegible]
1.46	1.45	1.45	1.46	1.44	1.41
1.48	1.48	1.48	1.45	1.45	1.47
1.55	1.55	1.55	1.55	1.52	1.[illegible]4
1.51	1.50	1.50	1.47	1.49	1.[illegible]
1.51	1.53	1.53	1.54	1.60	1.50
1.60	1.59	1.62	1.59	1.56	1.[illegible]
1.57	1.56	1.55	1.55	1.55	1.54

MEAN OF RMS= 1.[illegible]6

TIME ON TARGET (SECS)

0.21	1.25	1.[illegible]4	2.18	3.26	4.[illegible]
5.26	6.24	7.28	8.33	9.31	10.[illegible]
11.33	11.[illegible]4	12.13	13.18	14.19	14.[illegible]
15.65	16.68	17.[illegible]0	18.10	18.54	19.[illegible]1
20.13	21.14	22.18	22.[illegible]9	23.[illegible]9	24.[illegible]2
25.90	26.92	27.94	28.[illegible]8	29.74	30.[illegible]0
31.00	31.99	33.05	34.[illegible]0	35.07	36.[illegible]7
37.10	38.12	39.15	40.15	41.17	42.[illegible]1
43.23	44.22	45.22	45.22	47.25	48.[illegible]8
48.37	49.34	50.36	51.46	52.41	52.41
53.13	54.13	55.16	56.14	57.15	58.[illegible]0
59.19	60.19	60.81	61.[illegible]3	62.[illegible]8	64.[illegible]7
64.52	64.56	65.[illegible]2	66.[illegible]1	66.92	67.51
68.33	69.37	70.40	71.[illegible]8	72.37	73.41
74.43	75.42	76.47	77.50	78.[illegible]0	79.[illegible]0

SF test 7

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.77	1.37	1.95	3.01	2.91	2.14
2.38	2.46	2.38	2.28	2.17	2.13
2.02	1.99	2.01	2.01	1.96	1.94
1.87	1.88	1.80	1.79	1.80	1.73
1.75	1.77	1.74	1.81	1.82	1.83
1.89	1.85	1.84	1.94	2.01	2.00
1.99	1.97	2.00	1.93	1.92	1.90
1.87	1.87	1.85	1.84	1.83	1.85
1.87	1.87	1.86	1.84	1.82	1.83
1.90	1.90	1.90	1.88	1.86	1.88
1.85	1.83	1.83	1.82	1.79	1.80
1.78	1.78	1.76	1.76	1.75	1.75
1.77	1.78	1.75	1.76	1.76	1.77
1.72	1.73	1.72	1.71	1.70	1.72
1.77	1.75	1.74	1.73	1.72	1.72

MEAN OF RMS= 1.85

TIME ON TARGET (SECS)

0.00	0.71	1.54	1.98	1.85	2.45
3.53	4.51	5.47	6.53	6.94	7.74
8.91	9.68	9.71	10.30	11.31	12.13
13.33	14.34	15.38	16.39	17.39	18.39
18.65	18.88	19.46	19.85	19.81	20.24
21.20	22.25	23.19	23.28	23.27	23.88
24.73	25.69	26.68	27.74	28.75	29.78
30.79	31.79	32.85	33.87	34.89	35.12
35.05	35.68	36.70	37.72	38.72	39.78
39.65	39.79	40.79	41.79	42.86	43.96
44.85	45.82	46.89	47.88	48.92	49.91
50.97	51.99	52.97	53.98	54.97	56.02
56.13	56.42	57.54	58.56	59.42	60.41
61.47	62.47	63.48	64.50	65.53	66.17
66.05	66.50	67.51	68.55	69.50	70.28

SF test 8

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.94	1.91	2.82	3.25	3.04	[illegible]
2.63	2.46	2.34	2.23	2.59	[illegible]
2.49	2.45	2.42	2.35	2.27	[illegible]
2.18	2.14	2.09	2.04	2.01	[illegible]
2.01	2.02	1.97	1.96	1.96	[illegible]
1.89	1.94	2.00	1.98	1.94	[illegible]
1.94	1.96	1.97	1.92	1.91	[illegible]
1.86	1.89	1.85	1.86	1.83	[illegible]
1.82	1.80	1.80	1.78	1.77	[illegible]
1.74	1.75	1.74	1.71	1.68	[illegible]
1.80	1.77	1.78	1.77	1.74	[illegible]
1.76	1.82	1.81	1.79	1.79	[illegible]
1.77	1.77	1.77	1.76	1.75	[illegible]
1.73	1.72	1.73	1.71	1.74	[illegible]
1.73	1.72	1.71	1.72	1.70	[illegible]

MEAN OF RMS= 1.90

TIME ON TARGET (SECS)

0.06	0.54	0.98	0.50	1.15	[illegible]
3.18	4.20	5.16	6.21	6.26	[illegible]
8.91	7.18	8.19	9.20	10.24	[illegible]
12.23	13.28	14.26	15.28	16.35	[illegible]
17.19	18.03	19.01	[illegible]	21.09	[illegible]
23.10	23.54	23.55	24.12	24.67	[illegible]
25.92	26.17	27.16	28.20	29.20	[illegible]
31.25	31.62	31.93	33.08	33.98	[illegible]
35.05	36.07	37.10	38.13	[illegible]	[illegible]
40.99	41.49	42.51	43.47	44.48	[illegible]
45.11	46.13	46.98	48.02	49.01	[illegible]
50.77	50.82	51.57	52.38	[illegible]	[illegible]
55.42	55.94	56.88	57.72	[illegible]	[illegible]
60.76	61.79	62.78	63.75	63.76	[illegible]
65.42	66.46	67.48	68.50	69.46	[illegible]

SF test 9

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.24	1.76	1.58	1.48	1.41	1.39
1.46	1.47	1.47	1.36	1.30	1.32
1.20	1.22	1.25	1.33	1.35	1.38
1.61	1.55	1.52	1.54	1.52	1.71
1.78	1.76	1.73	1.71	1.73	1.77
1.76	1.79	1.76	1.76	1.73	1.70
1.70	1.66	1.66	1.66	1.64	1.60
1.60	1.68	1.67	1.64	1.65	1.66
1.61	1.61	1.64	1.74	1.72	1.71
1.72	1.69	1.69	1.66	1.66	1.66
1.65	1.63	1.63	1.61	1.60	1.61
1.61	1.61	1.61	1.61	1.59	1.60
1.57	1.57	1.57	1.55	1.55	1.55
1.54	1.54	1.56	1.58	1.58	1.57
1.56	1.56	1.54	1.55	1.55	1.54

MEAN OF RMS= 1.60

TIME ON TARGET (SECS)

0.11	1.14	1.59	2.55	3.58	4.56
4.33	5.31	6.31	7.38	8.36	9.38
10.36	11.26	11.38	12.39	13.45	13.94
13.81	14.81	15.88	16.86	17.88	18.90
18.33	19.36	20.36	21.39	22.42	22.82
22.99	23.97	25.00	26.05	27.05	28.07
29.04	30.12	31.12	32.13	33.10	34.14
35.14	35.13	35.96	36.93	37.97	38.98
40.02	41.03	41.73	41.72	42.43	43.47
44.51	45.47	46.52	47.59	48.53	49.51
50.61	51.56	52.59	53.62	54.64	55.65
55.93	56.56	57.57	58.59	59.66	60.70
61.66	62.63	63.67	64.75	65.68	66.73
67.76	68.77	69.22	69.53	70.58	71.60
72.58	73.62	74.61	75.61	76.72	76.72

SF test 10

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.12	1.11	1.11	1.36	1.11	[illegible]
0.94	1.11	0.94	0.93	1.46	[illegible]
1.41	1.39	1.34	1.38	1.63	[illegible]
1.57	1.57	1.57	1.49	1.48	[illegible]
1.45	1.44	1.45	1.36	1.33	[illegible]
1.49	1.48	1.47	1.43	1.43	[illegible]
1.39	1.41	1.37	1.43	1.42	[illegible]
1.42	1.45	1.49	1.47	1.46	[illegible]
1.39	1.42	1.41	1.44	1.39	1.41
1.41	1.37	1.35	1.36	1.35	[illegible]
1.34	1.33	1.32	1.33	1.31	[illegible]
1.31	1.35	1.35	1.34	1.34	[illegible]
1.33	1.33	1.32	1.31	1.39	[illegible]
1.44	1.42	1.40	1.41	1.41	[illegible]
1.40	1.41	1.43	1.43	1.44	[illegible]

MEAN OF RMS= 1.42

TIME ON TARGET (SECS)

0.28	1.01	2.00	3.04	4.05	[illegible]
6.05	7.10	8.13	9.06	9.45	[illegible]
11.29	12.31	13.31	14.25	14.26	[illegible]
16.08	17.08	18.11	19.03	20.15	[illegible]
22.17	23.17	24.15	25.13	26.19	[illegible]
27.19	28.23	29.24	30.25	31.24	[illegible]
33.28	34.33	35.33	35.74	36.52	[illegible]
38.55	38.59	39.24	40.25	41.27	[illegible]
43.29	44.37	45.36	46.36	47.36	[illegible]
49.43	50.43	51.37	52.44	53.44	[illegible]
55.47	56.52	57.49	58.57	59.53	[illegible]
61.59	62.00	62.31	63.30	64.32	[illegible]
66.32	67.42	68.38	69.41	69.56	[illegible]
70.93	71.97	72.98	73.93	75.01	[illegible]
77.07	77.57	77.56	78.22	79.22	[illegible]

SF test 11

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.57	1.11	1.57	1.11	1.22	1. 0
1.68	1.24	1.36	1.56	1.3	1. 4
1.27	1.26	1.21	1.30	1.14	1.11
1.16	1.16	1.11	1.18	1.11	1.21
1.37	1.36	1.31	1.31	1.32	1.31
1.35	1.44	1.43	1.43	1.40	1.41
1.59	1.36	1.40	1.38	1.34	1.44
1.34	1.39	1.39	1.38	1.35	1.37
1.31	1.33	1.33	1.30	1.32	1. 0
1.32	1.27	1.28	1.28	1.26	1.33
1.32	1.31	1.32	1.29	1.30	1. 9
1.28	1.29	1.29	1.30	1.29	1.. .
1.28	1.29	1.24	1.26	1.26	1.27
1.28	1.30	1.31	1.29	1.28	1.. 8
1.28	1.27	1.27	1.30	1.31	1.30

MEAN OF RMS= 1.32

TIME ON TARGET (SECS)

0.30	1.33	2.34	3. 5	4.40	4.71
5.46	6.50	7.51	8.50	9.53	10. 0
11.58	12.56	13.55	14.56	15.65	16. 5
17.68	18.71	19.70	20.68	21.63	21. 5
22.60	23.57	24.59	25.62	26.64	27. 4
28.45	28.72	29.77	30.70	31.79	32.77
33.82	34.80	35.82	36. 3	37.83	3 . 6
39.64	39.95	40.93	41. 3	42.99	4 . 9
45.03	45.38	47.02	46.07	49.04	5 . 0
51.05	52.11	53.15	54.12	55.14	. . .
56.38	57.38	58.46	59.42	60.47	61.47
62.50	63.47	64.17	64.75	65.76	. . 5
67.77	68.78	69.77	70.65	71.78	7 . 2
73.52	73.77	74.81	75.78	76.82	77. 1
78.87	79.83	80.86	81.21	81.80	. . 0

SF test 12

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

2.52	1.37	1.70	2.00	1.56	1.70
1.57	1.41	1.43	1.51	1.27	1.74
1.25	1.11	1.21	1.21	1.17	1.43
1.37	1.36	1.32	1.34	1.40	1.47
1.33	1.41	1.36	1.36	1.35	1.34
1.32	1.30	1.31	1.26	1.28	1.35
1.25	1.24	1.23	1.25	1.22	1.31
1.19	1.24	1.21	1.25	1.22	1.30
1.20	1.19	1.19	1.18	1.16	1.21
1.24	1.24	1.24	1.23	1.21	1.31
1.20	1.21	1.19	1.19	1.19	1.17
1.17	1.18	1.25	1.26	1.25	1.24
1.24	1.25	1.26	1.26	1.26	1.29
1.25	1.24	1.24	1.22	1.23	1.26
1.22	1.23	1.22	1.22	1.30	1.27

MEAN OF RMS= 1.27

TIME ON TARGET (SECS)

0.08	1.08	1.71	2.33	3.34	4.92
5.39	6.41	7.36	8.43	9.46	10.42
11.48	12.51	13.48	14.54	15.51	16.53
16.60	17.68	18.69	19.56	20.69	21.72
21.74	22.74	23.78	24.74	25.78	26.76
27.74	28.79	29.83	30.84	31.88	32.90
33.94	34.87	35.94	36.95	37.98	38.98
40.00	40.38	41.43	42.43	43.42	44.43
45.44	46.46	47.53	48.51	49.53	50.49
50.73	51.52	52.57	53.56	54.57	55.61
56.58	57.62	58.62	59.64	60.67	61.62
62.68	63.72	63.67	64.50	65.52	66.48
67.56	68.25	68.83	69.41	70.05	71.07
72.87	73.87	74.93	75.95	76.92	77.94
78.93	79.98	81.01	82.01	83.07	83.91

SF test 13

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

0.00	1.76	0.64	0.78	0.86	1.01
1.03	0.96	0.90	0.93	0.92	1.00
0.97	0.98	1.03	1.04	1.00	0.94
0.98	0.96	1.23	1.29	1.34	1.32
1.29	1.27	1.46	1.42	1.41	1.36
1.38	1.37	1.35	1.33	1.32	1.30
1.29	1.25	1.29	1.29	1.34	1.3
1.36	1.35	1.40	1.42	1.41	1.39
1.38	1.34	1.34	1.35	1.37	1.41
1.33	1.34	1.32	1.33	1.31	1.30
1.29	1.30	1.29	1.28	1.27	1.2
1.26	1.28	1.30	1.27	1.26	1.27
1.27	1.27	1.25	1.24	1.25	1.24
1.29	1.28	1.28	1.29	1.26	1.2
1.24	1.26	1.25	1.25	1.24	1.24

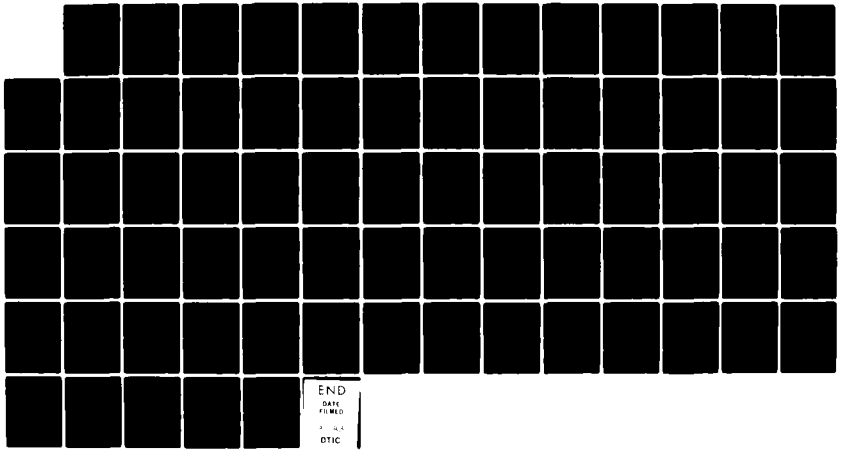
MEAN OF RMS= 1.28

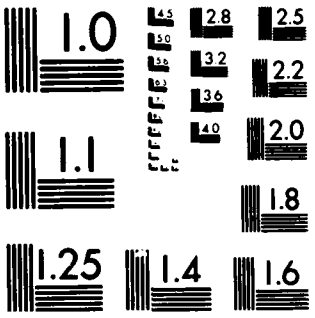
TIME ON TARGET (SECS)

6.46	1.36	2.46	3.46	4.46	5.46
6.51	7.54	8.54	9.56	10.58	11.61
11.94	12.93	13.93	14.91	15.94	16.91
17.96	18.98	19.50	19.91	20.96	21.96
22.97	24.02	24.15	25.19	26.17	27.19
28.18	29.23	30.22	31.25	32.27	33.29
34.26	35.27	36.29	37.34	37.54	38.56
39.52	40.53	40.85	41.81	42.83	43.85
44.63	45.61	46.63	47.68	48.66	49.68
50.74	51.74	52.77	53.82	54.74	55.71
56.81	57.78	58.83	59.85	60.84	61.91
62.92	63.10	64.15	65.17	66.12	67.15
68.15	69.17	70.17	71.18	72.25	73.27
73.50	74.47	75.48	76.51	77.52	78.53
79.52	80.56	81.55	82.59	83.61	84.63

AD-A124 699 EXPERIMENTAL TESTING OF FLYING QUALITIES THEORIES(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL OF ENGINEERING N H KRYS DEC 82 AFIT/GE/EE/82D-43 3/3

UNCLASSIFIED F/G 14/2 NL





SF test 14

ROLL
STEP FUNCTION

RMS VALUE OF ERROR

1.57	1.57	1.44	1.11	1.11	1.[illegible]
1.62	1.56	1.46	1.[illegible]	1.[illegible]	[illegible]
1.26	1.26	1.24	1.14	1.11	1.14
1.14	1.02	1.16	1.11	1.0[illegible]	1.[illegible]
1.11	1.04	1.07	1.15	1.1[illegible]	1.13
1.09	1.09	1.06	1.08	1.[illegible]	[illegible]
1.05	1.22	1.22	1.2[illegible]	1.21	1.[illegible]
1.13	1.17	1.17	1.15	1.1[illegible]	1.[illegible]
1.21	1.19	1.22	1.19	1.22	1.[illegible]
1.22	1.24	1.21	1.1[illegible]	1.2[illegible]	1.17
1.14	1.15	1.16	1.16	1.16	1.1[illegible]
1.16	1.17	1.16	1.17	1.1[illegible]	1.[illegible]
1.15	1.15	1.14	1.16	1.1[illegible]	1.14
1.17	1.15	1.15	1.13	1.13	1.15
1.13	1.16	1.15	1.16	1.14	1.14

MEAN OF RMSE 1.16

TIME ON TARGET (SEC)

0.55	1.51	2.55	3.51	[illegible]	[illegible]
5.41	6.38	7.46	8.43	[illegible]	[illegible]
11.51	12.54	13.56	14.[illegible]	15.51	1[illegible]
17.56	18.59	19.55	20.[illegible]	21.[illegible]	[illegible]
23.67	24.69	25.60	26.[illegible]	27.62	[illegible]
29.04	30.03	31.09	[illegible]	33.1[illegible]	[illegible]
35.06	36.22	36.04	[illegible]	[illegible]	[illegible]
40.14	41.22	42.21	[illegible]	[illegible]	[illegible]
45.09	46.04	47.14	48.12	[illegible]	[illegible]
51.16	52.17	53.15	54.[illegible]	[illegible]	[illegible]
57.24	58.26	59.23	[illegible]	[illegible]	[illegible]
62.55	63.55	64.55	[illegible]	[illegible]	[illegible]
68.67	69.68	70.67	70.[illegible]	[illegible]	[illegible]
73.58	75.02	76.01	77.01	[illegible]	[illegible]
79.36	80.38	81.39	[illegible]	[illegible]	[illegible]

DS test 1

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

0.00	0.00	1.12	1.14	1.22	1.12
1.11	0.96	1.17	1.16	1.06	1.07
1.02	0.99	1.06	1.09	1.11	1.11
1.08	1.04	1.06	1.11	1.18	1.18
1.07	1.11	1.09	1.07	1.05	1.07
1.11	1.11	1.06	1.05	1.10	1.08
1.08	1.10	1.10	1.15	1.13	1.09
1.05	1.07	1.09	1.11	1.11	1.09
1.09	1.09	1.10	1.10	1.12	1.13
1.09	1.08	1.12	1.08	1.10	1.09
1.10	1.11	1.13	1.09	1.10	1.10
1.11	1.10	1.11	1.10	1.13	1.14
1.10	1.11	1.10	1.15	1.11	1.10
1.11	1.11	1.11	1.13	1.10	1.12
1.11	1.11	1.13	1.11	1.11	1.11

MEAN OF RMS= 1.09

TIME ON TARGET (SECS)

0.00	1.99	2.25	3.25	5.00	5.00
5.85	6.88	7.01	7.99	9.03	10.09
11.06	12.08	12.46	13.03	13.56	14.01
15.61	15.80	16.63	17.59	18.45	19.41
20.40	21.59	22.42	23.50	23.54	24.58
25.56	26.25	27.04	28.09	29.12	30.10
31.14	32.09	32.35	32.93	33.83	34.40
35.38	36.43	36.58	37.42	38.25	39.19
39.94	40.93	41.62	42.22	42.67	43.74
44.73	45.13	46.19	47.18	47.67	48.56
49.68	50.71	51.71	52.56	52.98	54.02
55.02	55.28	55.58	56.58	57.87	58.82
59.86	60.47	61.22	62.22	62.56	63.56
64.60	65.32	65.56	66.55	67.60	68.59
69.27	70.28	70.98	71.55	72.19	73.16

DS test 2

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.10	1.07	1.11	1.[illegible]	1.[illegible]	[illegible].1
1.03	1.04	1.17	1.11	1.06	1.07
1.20	1.11	1.1[illegible]	1.1[illegible]	1.0[illegible]	1.[illegible]
1.05	1.05	1.03	1.09	1.04	1.[illegible]
1.07	1.05	1.03	1.03	1.05	1.[illegible]
1.08	1.04	1.04	0.99	1.03	1.[illegible]
1.05	1.02	1.07	1.05	1.06	1.[illegible]
1.06	1.05	1.05	1.05	1.05	1.[illegible]
1.05	1.04	1.03	1.07	1.02	1.[illegible]
1.03	0.96	1.02	1.04	1.03	1.[illegible]
0.98	1.05	1.10	1.02	1.05	1.[illegible]
1.03	1.04	1.04	1.05	1.05	1.[illegible]
1.06	1.05	1.04	1.03	1.04	1.[illegible]
1.04	1.05	1.07	1.08	1.06	1.[illegible]
1.07	1.06	1.06	1.09	1.07	1.[illegible]

MEAN OF RMS= 1.05

TIME ON TARGET (SECS)

0.20	0.78	1.75	2.78	3.74	[illegible].75
5.81	6.78	7.64	8.40	9.41	1[illegible].[illegible]4
10.69	11.71	12.75	13.71	14.7[illegible]	1[illegible].[illegible]4
16.81	17.83	18.95	19.85	20.84	21.[illegible]
22.89	23.82	24.88	25.[illegible]0	26.45	27.[illegible]
28.48	29.52	29.92	30.79	31.79	3[illegible].[illegible]
33.50	34.19	35.22	36.24	37.22	3[illegible].1[illegible]
39.22	40.22	41.28	42.26	43.26	4[illegible].[illegible]
45.28	46.32	47.34	48.36	49.41	[illegible].[illegible]7
51.36	52.37	53.42	54.38	55.46	[illegible].[illegible]
57.01	57.54	58.57	59.54	60.54	61.[illegible]
62.36	63.07	64.03	65.15	66.00	67.1[illegible]
68.18	68.68	69.66	70.70	71.72	7[illegible].[illegible]7
73.40	74.38	74.37	75.05	76.06	77.1[illegible]
77.91	78.41	79.16	80.18	81.1[illegible]	[illegible].17

DS test 3

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

2.4[illegible]	2.10	[illegible]	[illegible]	1.[illegible]	[illegible]
1.[illegible]	1.[illegible]	1.[illegible]	1.[illegible]	1.11	1.[illegible]
1.27	1.23	1.25	1.08	1.18	1.14
1.17	1.22	1.14	1.06	1.16	1.1[illegible]
1.20	1.13	1.07	1.11	1.07	1.[illegible]
1.09	1.08	1.10	1.11	1.05	1.[illegible]
1.11	1.14	1.10	1.11	1.07	1.10
1.07	1.03	1.07	1.09	1.09	1.[illegible]
1.07	1.09	1.03	1.07	1.06	1.[illegible]
1.06	1.06	1.05	1.08	1.06	1.[illegible]
1.06	1.07	1.06	1.06	1.06	1.05
1.05	1.07	1.06	1.06	1.06	1.[illegible]
1.07	1.06	1.05	1.07	1.07	1.07
1.05	1.06	1.06	1.08	1.06	1.[illegible]
1.05	1.06	1.06	1.07	1.07	1.[illegible]

MEAN OF RMS= 1.09

TIME ON TARGET (SECS)

0.06	1.13	2.08	3.10	4.15	.15
6.13	7.18	8.19	9.19	10.19	11.[illegible]
12.26	13.25	14.31	15.30	16.31	17.31
18.31	19.39	20.36	21.45	22.39	[illegible]
24.32	25.30	26.29	27.33	28.34	2[illegible]
30.39	31.42	32.39	33.43	34.37	34.[illegible]
35.68	36.72	37.48	37.92	38.93	3[illegible]
41.02	42.02	43.02	44.03	45.06	45.[illegible]
46.81	47.82	48.83	49.87	50.83	51.[illegible]
52.86	53.92	54.91	55.[illegible]	56.92	57.[illegible]
58.97	60.02	60.94	61.53	62.56	[illegible]
64.51	65.53	66.58	67.57	68.60	69.[illegible]
70.47	71.46	72.10	72.67	72.[illegible]	73.[illegible]
74.91	75.95	76.97	78.01	79.09	80.[illegible]
80.90	82.03	82.97	83.[illegible]	83.82	84.[illegible]

DS test 4

ROLL

SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

0.00	0.00	1.19	1.24	0.50	.00
1.03	0.00	1.17	0.93	1.00	1.00
1.02	0.79	0.91	0.96	0.99	1.01
0.98	0.96	1.00	0.97	0.98	0.96
0.97	0.97	0.98	0.96	0.99	0.97
0.91	0.92	0.99	0.97	0.98	0.97
1.02	1.00	0.97	0.96	0.95	0.97
0.94	0.99	0.95	0.99	0.94	0.97
0.94	0.93	0.97	0.97	0.96	0.97
0.95	0.94	0.95	0.96	0.95	0.97
0.95	0.97	0.95	0.96	0.95	0.97
0.95	0.95	0.97	0.95	0.96	0.95
0.98	0.96	0.97	0.97	0.95	0.94
0.95	0.95	0.99	0.95	0.95	0.95
0.96	0.97	0.94	0.96	0.96	0.96

MEAN OF RMS= 0.96

0.00	1.00	2.00	3.00	4.00	5.00
6.00	7.00	8.00	9.00	10.00	11.00
12.91	13.96	14.91	15.91	16.93	17.92
17.61	18.05	19.08	20.08	21.10	22.09
23.16	24.14	25.15	26.15	27.13	28.14
29.20	30.20	31.20	32.17	33.20	34.19
34.62	35.62	36.64	37.63	38.60	39.72
40.72	41.72	42.74	43.79	44.74	45.74
46.83	47.44	48.23	49.14	49.94	50.92
51.95	52.48	53.36	53.97	54.99	55.03
57.16	57.58	58.64	59.19	60.27	61.27
62.25	63.18	63.86	64.97	65.93	66.91
67.88	68.95	69.92	70.98	71.62	72.93
73.62	74.06	75.68	76.68	77.76	78.71
79.71	80.72	81.75	82.73	83.80	84.77

DS test 5

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.11	1.11	1.11	1.07	1.07	1.0
1.11	1.11	1.10	1.11	1.02	1.0
0.97	1.07	1.03	1.04	0.93	1.01
0.99	1.02	1.00	0.98	1.09	1.0
0.99	1.02	1.03	1.01	0.99	1.0
1.04	1.06	1.02	1.04	1.05	1.01
1.02	0.95	1.04	1.02	1.00	1.00
1.03	1.03	1.03	1.01	0.99	1.01
0.99	0.92	1.01	1.00	1.04	1.03
1.02	1.02	1.06	1.08	0.92	0.9
1.00	1.00	1.00	1.01	1.01	1.00
1.01	1.03	1.02	1.03	1.03	1.01
1.01	1.02	1.02	1.02	1.00	1.02
1.02	1.01	1.05	1.03	1.06	1.02
1.02	1.03	1.02	1.01	1.02	1.02

MEAN OF RMS= 1.02

TIME ON TARGET (SECS)

0.02	1.29	2.01	5.03	3.04	4.09
5.05	7.04	8.08	9.10	10.11	11.14
12.15	12.33	13.28	14.33	15.31	16.38
17.33	18.39	19.41	19.38	20.92	21.98
22.89	23.37	24.42	25.42	26.40	27.3
27.54	28.58	29.62	30.64	31.69	32.7
33.67	34.50	34.90	35.89	36.92	37.94
38.99	39.98	41.04	41.73	42.58	43.92
44.52	45.54	46.19	46.73	47.58	48.7
49.74	50.77	51.76	52.78	53.48	54.47
55.52	55.84	56.88	57.19	58.21	59.18
59.96	61.01	61.71	62.67	63.77	64.77
63.75	66.63	66.55	67.43	68.46	69.17
70.03	70.61	71.63	72.40	73.37	74.40
75.08	75.81	76.85	77.81	78.83	79.8

DS test 6

ROLL

SUM OF SINE WAVES FUNCTION

RMS VALUE OF TRACK

1.1[illegible]	1.11	0.91	1.[illegible]	1.[illegible]	1.01
1.11	1.04	[illegible]	1.[illegible]	[illegible]	1.[illegible]
0.97	1.03	1.05	0.96	1.14	1.01
1.05	0.96	0.94	1.00	0.96	0.[illegible]
0.94	1.00	0.93	0.96	1.01	1.01
0.98	1.00	0.95	0.93	0.[illegible]	0.[illegible]
1.00	0.92	0.96	0.96	0.93	0.[illegible]
0.96	0.99	1.01	1.0[illegible]	1.00	1.[illegible]
0.99	0.97	1.01	1.00	0.93	0.[illegible]
1.00	1.00	1.00	1.00	0.9[illegible]	0.[illegible]
0.94	0.98	0.99	0.[illegible]	0.97	0.[illegible]
1.00	1.00	0.95	0.[illegible]	0.97	0.[illegible]
0.97	0.98	1.01	1.00	0.97	0.[illegible]
0.94	0.99	0.98	0.97	0.97	0.[illegible]
0.96	0.97	0.97	0.99	0.96	0.[illegible]

MEAN OF RMS= 0.98

TIME ON TARGET (SECS)

0.04	0.83	1.[illegible]	2.[illegible]	3.[illegible]	[illegible]
5.61	6.60	7.25	8.[illegible]	[illegible]	11.[illegible]
11.53	12.56	13.[illegible]	14.00	15.05	15.[illegible]
17.06	18.05	19.06	20.14	21.12	22.[illegible]
23.10	24.12	24.53	25.[illegible]	26.6[illegible]	27.[illegible]
28.62	29.65	30.64	31.58	32.73	33.7[illegible]
34.73	35.54	36.28	37.32	38.29	39.[illegible]
39.43	40.47	40.77	41.79	42.87	43.7[illegible]
44.82	45.26	45.94	46.24	47.97	48.[illegible]
49.97	51.01	52.02	53.04	54.04	55.[illegible]
56.08	57.09	58.13	59.12	60.13	61.13
62.13	63.15	64.20	65.22	66.16	67.[illegible]
68.25	69.08	70.00	70.43	71.46	72.[illegible]
72.78	73.68	74.66	75.64	76.72	77.[illegible]
78.72	79.77	80.76	81.76	82.76	83.[illegible]

DS test 7

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.[illegible]	1.11	1.[illegible]	[illegible]	1.[illegible]	[illegible]
1.57	1.[illegible]4	1.[illegible]3	1.[illegible]	1.7[illegible]	1.[illegible]
1.74	1.73	1.78	1.62	1.62	1.[illegible]6
1.69	1.72	1.66	1.64	1.64	1.[illegible]7
1.64	1.65	1.59	1.60	1.62	1.[illegible]3
1.76	1.79	1.75	1.74	1.71	1.75
1.74	1.76	1.73	1.79	1.70	1.[illegible]7
1.74	1.78	1.80	1.75	1.77	1.77
1.75	1.76	1.75	1.71	1.73	1.[illegible]4
1.74	1.74	1.73	1.74	1.75	1.[illegible]7
1.76	1.75	1.74	1.74	1.76	1.72
1.77	1.77	1.77	1.[illegible]4	1.[illegible]4	1.[illegible]4
1.76	1.75	1.73	1.71	1.72	1.74
1.76	1.79	1.76	1.76	1.77	1.[illegible]6
1.78	1.77	1.77	1.76	1.74	1.[illegible]4

MEAN OF RMS= 1.72

TIME ON TARGET (SECS)

0.45	1.19	1.98	2.[illegible]	5.[illegible]	[illegible]
4.74	4.78	5.13	5.85	6.08	[illegible]1
5.89	7.93	8.53	9.54	9.76	10.[illegible]1
10.38	10.54	11.45	12.51	12.74	13.[illegible]5
13.30	14.31	14.58	15.50	16.56	17.[illegible]5
17.03	17.76	18.71	19.70	20.36	21.[illegible]
20.77	21.45	22.52	23.16	23.95	24.[illegible]3
24.42	24.48	25.20	25.73	26.39	27.[illegible]4
26.93	27.27	28.28	29.29	30.32	31.[illegible]5
30.88	30.82	31.65	32.50	32.54	33.[illegible]3
33.59	34.05	34.58	35.13	35.43	36.[illegible]6
35.85	36.22	36.88	37.93	38.40	39.[illegible]2
39.10	40.10	40.58	41.29	42.31	43.[illegible]7
43.18	43.44	44.47	45.12	45.76	46.[illegible]7
46.29	47.09	48.16	49.14	50.12	50.[illegible]6

- DS test 8

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.13	1.12	0.64	1.24	1.3.	1.23
1.48	1.30	1.34	1.32	1.42	1.4
1.34	1.36	1.28	1.39	1.50	1.43
1.53	1.47	1.51	1.50	1.50	1.47
1.56	1.56	1.57	1.53	1.56	1.50
1.55	1.51	1.46	1.55	1.51	1.51
1.57	1.55	1.53	1.56	1.54	1.54
1.54	1.54	1.52	1.54	1.54	1.52
1.52	1.48	1.50	1.52	1.52	1.53
1.54	1.56	1.57	1.56	1.54	1.56
1.55	1.54	1.52	1.53	1.52	1.52
1.52	1.52	1.52	1.51	1.53	1.53
1.54	1.52	1.52	1.50	1.51	1.51
1.49	1.50	1.49	1.50	1.50	1.48
1.49	1.48	1.48	1.48	1.48	1.47

MEAN OF RMS= 1.50

TIME ON TARGET (SECS)

0.56	1.13	2.09	2.43	3.01	.25
3.85	4.38	4.85	5.31	5.83	5.41
6.91	7.94	8.55	9.21	9.19	9.36
10.48	11.18	11.71	12.34	12.29	12.44
12.96	13.68	14.21	13.23	13.34	13.45
16.54	17.63	18.33	18.24	18.76	19.18
19.25	19.83	19.95	21.02	21.45	21.54
22.49	23.54	24.53	24.25	25.39	25.43
26.87	27.88	28.09	28.52	29.94	29.23
29.62	30.03	30.32	31.29	31.30	31.48
32.69	33.70	34.47	34.47	35.32	35.75
36.45	37.22	37.62	37.98	38.23	38.73
39.18	39.77	40.82	41.79	42.13	42.2
43.02	43.99	44.62	45.14	45.94	46.23
46.52	47.53	48.56	48.96	49.37	50.54

DS test 9

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.15	0.00	0.91	0.97	1.11	[illegible]
1.33	0.98	0.97	1.12	1.16	[illegible]
1.07	1.22	1.17	1.11	1.14	1.14
1.08	0.99	1.11	1.18	1.25	1.11
1.07	1.09	1.00	1.11	1.09	1.[illegible]
1.09	1.09	1.13	1.06	1.06	1.[illegible]
1.06	1.10	1.10	1.08	1.06	1.10
1.03	1.07	1.05	1.06	1.06	1.[illegible]
1.06	1.05	1.05	1.08	1.08	1.07
1.04	1.03	1.06	1.07	1.05	1.
1.05	1.04	1.07	1.08	1.08	1.[illegible]
1.06	1.08	1.06	1.02	1.06	1.[illegible]
1.05	1.04	1.04	1.04	1.07	1.04
1.06	1.05	1.04	1.05	1.06	1.[illegible]
1.06	1.06	1.06	1.08	1.06	1.[illegible]

MEAN OF RMS= 1.07

TIME ON TARGET (SECS)

0.96	1.29	2.23	2.46	3.46	[illegible]
5.25	5.99	6.15	7.19	8.16	[illegible]
9.90	10.84	11.91	12.15	13.00	13.[illegible]
14.96	15.98	15.99	16.71	17.71	17.71
19.71	20.72	21.74	22.75	23.77	24.[illegible]
25.75	26.84	27.82	28.80	29.77	30.[illegible]
31.85	32.90	33.93	33.88	34.95	[illegible]
36.96	37.95	38.80	38.97	38.97	40.[illegible]
41.41	42.18	42.68	43.72	44.28	45.11
46.15	47.14	47.94	48.89	49.91	50.[illegible]
51.92	52.82	53.38	53.91	54.72	55.11
56.11	56.79	57.77	58.78	59.61	60.11
61.87	62.87	63.80	64.91	65.32	66.[illegible]
67.38	68.17	68.52	69.30	69.60	70.[illegible]
71.26	72.02	72.70	72.[illegible]	73.91	74.[illegible]

DS test 10

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.12	1.77	1.44	1.47	1.[illegible]	[illegible]
1.11	1.30	1.17	1.[illegible]1	1.06	1.[illegible]4
1.19	1.11	0.99	1.04	1.14	1.[illegible]1
1.05	1.05	1.03	0.98	0.96	1.[illegible]1
0.97	1.02	1.00	1.01	0.99	[illegible].1
0.98	1.00	0.99	0.[illegible]1	0.98	[illegible]
0.97	0.97	0.96	0.[illegible]5	0.98	0.97
0.99	0.98	1.01	0.97	0.97	[illegible]
0.94	0.96	0.95	0.[illegible]7	0.94	[illegible]
0.94	0.95	0.98	0.[illegible]9	0.98	[illegible]
0.97	0.97	0.98	0.96	0.97	[illegible]
0.96	0.95	0.95	0.[illegible]2	0.96	[illegible]
0.96	0.97	0.95	0.94	0.96	[illegible]
0.94	0.95	0.96	0.97	0.97	[illegible]
0.96	0.95	0.95	[illegible]	0.95	[illegible]

MEAN OF RMS= 0.96

TIME ON TARGET (SECS)

0.94	1.14	2.[illegible]	3.16	4.00	[illegible]3
5.46	6.51	[illegible].94	7.[illegible]3	8.99	[illegible]4
10.98	11.99	13.00	14.00	15.00	16.[illegible]0
17.01	18.03	19.05	20.03	21.0[illegible]	22.[illegible]5
23.12	24.10	25.10	26.09	27.12	28.[illegible]0
29.09	30.10	30.98	31.[illegible]2	32.84	33.[illegible]3
34.85	35.84	36.85	37.80	38.86	39.[illegible]4
40.54	41.52	42.54	43.52	44.53	45.[illegible]5
46.57	47.52	48.61	49.59	50.32	51.1[illegible]
52.09	53.11	53.74	[illegible].77	55.79	[illegible]8
57.81	58.22	59.23	60.26	61.26	[illegible]2
63.23	64.32	65.13	65.70	66.71	[illegible]1
68.70	69.72	70.83	71.73	72.75	[illegible]6
74.77	75.80	76.80	77.27	78.31	[illegible]3
80.33	81.38	82.34	83.34	84.43	[illegible]1

DS test 11

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

0.00	1.13	1.44	0.77	1.0	.45
0.74	1.04	0.95	0.98	1.04	1.11
1.07	0.98	0.95	0.96	0.83	0.77
0.99	1.02	0.97	0.95	1.01	0.98
0.99	1.00	0.91	0.94	0.99	0.97
0.96	1.04	0.97	0.97	0.98	0.94
1.00	0.99	1.04	0.98	1.00	1.05
0.99	0.98	0.98	0.98	0.97	0.96
0.98	0.98	0.95	1.00	0.99	0.99
0.98	0.97	0.95	0.99	0.98	0.97
1.00	0.98	0.98	0.98	0.98	0.96
1.00	0.97	0.95	0.97	0.96	0.95
0.98	0.98	0.98	0.98	0.98	0.97
0.99	0.96	0.97	0.96	0.97	0.97
0.97	0.97	0.98	0.98	0.98	0.98

MEAN OF RMS= 0.98

TIME ON TARGET (SECS)

1.00	1.98	2.48	3.50	4.44	.45
5.15	6.60	7.66	8.66	9.21	1.0
11.26	12.24	13.29	14.53	15.24	1.0
17.33	18.34	19.33	20.59	21.74	1.
22.64	25.59	24.50	25.64	26.54	7.
28.05	28.78	29.80	30.68	31.40	
33.40	34.43	35.47	36.47	37.53	
39.14	39.95	41.02	41.78	43.05	1
45.03	45.97	46.18	47.13	4 .13	
50.22	51.26	52.22	53.26	54.02	7
55.52	56.58	57.53	58.59	59.58	
61.27	62.32	63.30	64.97	64.81	
66.82	67.83	68.86	69.45	70.55	7
72.85	73.80	74.67	75.67	76.68	
78.75	79.72	80.72	81.80	82.79	

DS test 12

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.5[illegible]	1.5[illegible]	1.44	1.[illegible]	1.11	[illegible]
1.1[illegible]	1.11	[illegible]	1.[illegible]	1.01	[illegible]
1.25	1.05	1.07	0.[illegible]	0.97	1.[illegible]
1.02	1.02	1.03	0.[illegible]	1.01	[illegible]
0.94	1.00	1.05	0.[illegible]	1.01	[illegible]
0.98	0.94	0.95	0.[illegible]	0.9[illegible]	[illegible]
0.91	0.95	0.94	0.[illegible]	0.97	[illegible]
0.96	0.98	0.94	0.94	0.94	[illegible]
0.92	0.96	0.96	0.94	0.95	[illegible]
0.95	0.94	0.95	0.95	0.94	[illegible]
0.95	0.91	0.93	0.[illegible]	0.90	[illegible]
0.90	0.94	0.[illegible]	0.[illegible]	0.93	[illegible]
0.95	0.93	0.92	0.94	0.92	[illegible]
0.93	0.95	0.95	0.94	0.94	[illegible]
0.93	0.92	0.93	0.94	0.93	[illegible]

MEAN OF RMS= 0.95

TIME ON TARGET (SECS)

0.5[illegible]	0.65	1.54	2.66	3.9[illegible]	[illegible]
5.40	6.41	7.44	8.45	9.55	10.[illegible]
11.50	12.51	13.51	14.54	15.55	16.[illegible]
17.45	18.46	19.48	20.49	21.[illegible]	[illegible]
23.52	24.57	25.58	26.57	27.60	[illegible]
29.62	30.63	31.62	32.70	33.67	[illegible]
35.72	36.74	37.77	38.83	39.87	[illegible]
40.87	41.89	42.92	43.94	44.96	[illegible]
46.89	47.99	48.97	50.02	51.04	[illegible]
53.07	54.02	55.08	56.12	57.11	[illegible]
59.07	59.43	60.39	61.43	62.48	[illegible]
64.46	65.48	66.52	67.53	68.51	[illegible]
70.58	71.56	72.62	73.62	74.61	[illegible]
76.58	77.17	79.16	79.28	80.26	[illegible]
82.29	83.30	84.34	85.34	86.35	[illegible]

DS test 13

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.17	0.79	1.4[illegible]	[illegible]	1.31	[illegible].11
1.11	1.16	[illegible]	[illegible]	1.06	[illegible]
1.07	0.98	1.08	0.75	1.01	[illegible].91
1.05	0.96	0.97	0.95	0.98	[illegible]
0.99	1.07	0.93	0.96	1.05	1.[illegible]
0.91	0.94	0.95	0.95	1.0[illegible]	[illegible]
0.95	0.95	0.99	0.91	0.95	[illegible].94
0.91	0.95	0.94	0.93	0.97	[illegible].92
0.92	0.93	0.95	0.91	0.94	[illegible].94
0.94	0.93	0.95	0.93	0.95	[illegible].92
0.95	0.94	0.91	0.[illegible]	0.91	[illegible].93
0.95	0.92	0.93	0.92	0.94	[illegible].95
0.94	0.92	0.93	0.93	0.94	[illegible].92
0.93	0.[illegible]	0.92	0.[illegible]	0.94	[illegible].94
0.93	0.94	0.94	0.92	0.93	[illegible].92

MEAN OF RMS= 0.94

TIME ON TARGET (SECS)

0.08	1.19	2.18	3.20	4.21	.18
6.23	7.24	8.25	9.25	10.28	11.31
12.30	13.34	14.00	14.33	15.[illegible]	1[illegible]
17.85	18.88	19.91	20.[illegible]	21.33	2[illegible]
23.33	24.35	25.34	26.37	27.44	[illegible]
29.42	30.45	31.52	32.45	33.49	[illegible]
35.45	36.49	37.54	38.54	3[illegible]	[illegible]
41.61	42.61	43.61	44.67	45.69	[illegible]
47.64	48.66	49.66	50.73	51.69	[illegible]
53.76	54.78	55.76	56.78	57.81	[illegible]
59.81	60.87	61.83	62.88	63.87	[illegible]
65.66	66.73	67.63	68.68	69.70	[illegible]
71.71	72.73	73.76	74.72	75.77	[illegible]
77.80	78.80	79.83	80.87	81.83	[illegible]
83.91	84.92	85.89	86.[illegible]	87.85	[illegible]

MK test 1

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.1[illegible]	1.5[illegible]	2.0[illegible]	1.47	1.5[illegible]	[illegible].7
1.57	1.52	1.65	1.49	1.20	1.[illegible]
1.54	1.42	1.37	1.35	1.29	1.[illegible]
1.50	1.38	1.41	1.51	1.51	1.[illegible]
1.35	1.34	1.30	1.51	1.32	1.[illegible]
1.50	1.31	1.28	1.50	1.50	1.[illegible]7
1.50	1.35	1.34	1.35	1.57	1.[illegible]
1.57	1.40	1.39	1.38	1.41	1.[illegible]7
1.57	1.43	1.44	1.45	1.44	1.[illegible]1
1.68	1.70	1.67	1.69	1.67	1.[illegible]
1.66	1.68	1.69	1.67	1.68	1.[illegible]
1.67	1.68	1.67	1.68	1.67	1.[illegible]
1.67	1.68	1.71	1.70	1.67	1.[illegible]7
1.70	1.75	1.75	1.75	1.72	1.[illegible]2
1.72	1.71	1.72	1.76	1.81	1.[illegible]

MEAN OF RMS= 1.50

TIME ON TARGET (SECS)

0.61	0.88	1.25	1.25	2.25	.1
2.98	5.99	5.01	6.33	7.05	7.[illegible]
9.80	8.81	9.68	10.[illegible]	11.65	1[illegible]
12.59	13.06	14.01	14.[illegible]	15.21	1[illegible]
17.31	17.81	18.28	19.[illegible]	20.33	21.[illegible]
21.65	22.28	22.52	23.[illegible]	24.58	25.[illegible]
25.95	26.38	26.[illegible]	27.20	27.22	27.[illegible]
27.67	28.13	29.15	30.18	31.15	3[illegible]
32.67	32.70	33.[illegible]	34.34	34.63	34.[illegible]
34.57	34.82	35.15	35.[illegible]	3[illegible]	[illegible]
38.87	38.88	39.[illegible]	39.[illegible]	40.[illegible]	[illegible]
40.84	41.52	42.14	42.17	42.17	42.[illegible]
45.54	43.74	45.99	45.03	45.64	[illegible]
46.76	46.86	47.82	48.89	49.81	[illegible]
50.81	51.86	52.27	52.[illegible]	5[illegible]	[illegible]

MK test 2

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.[illegible]	1.[illegible]	1.[illegible]	1.[illegible]	1.[illegible]	[illegible]
1.11	1.10	1.[illegible]	1.17	1.16	1.11
1.15	1.15	1.11	1.21	1.29	1.[illegible]
1.55	1.51	1.[illegible]	1.52	1.27	[illegible]
1.44	1.44	1.46	1.47	1.44	1.47
1.46	1.49	1.47	1.45	1.46	[illegible]
1.41	1.43	1.44	1.42	1.41	1.[illegible]
1.42	1.41	1.39	1.39	1.39	[illegible]
1.41	1.38	1.36	1.37	1.37	1.41
1.39	1.37	1.38	1.39	1.38	1.37
1.38	1.38	1.38	1.38	1.37	1.37
1.38	1.37	1.41	1.38	1.37	1.37
1.38	1.36	1.38	1.38	1.37	[illegible]
1.38	1.33	1.34	1.36	1.37	[illegible]
1.36	1.35	1.34	1.35	1.34	1.[illegible]

MEAN OF RMS= 1.37

TIME ON TARGET (SECS)

0.54	1.14	2.19	3.20	4.27	[illegible]
5.43	6.45	7.59	8.51	[illegible]	[illegible]
10.25	10.98	11.96	12.[illegible]	12.91	[illegible]
14.25	14.93	15.33	16.38	[illegible]	17.[illegible]
17.48	17.94	18.93	19.98	20.18	[illegible]
21.19	21.48	21.92	22.44	23.52	[illegible]
24.86	25.77	26.78	27.69	28.32	[illegible]
29.13	30.07	31.09	32.09	[illegible]	[illegible]
34.14	34.37	35.37	36.30	[illegible]	[illegible]
37.85	38.08	38.97	39.87	40.27	[illegible]
40.86	41.74	42.76	43.77	44.74	[illegible]
45.47	45.91	46.07	46.[illegible]	47.91	[illegible]
48.86	49.79	50.78	51.51	[illegible]	[illegible]
53.13	53.78	54.73	55.18	[illegible]	[illegible]
57.72	58.21	59.22	60.09	[illegible]	[illegible]

MK test 3

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

0.00	1.11	1.43	0.97	1.40	1.21
1.1[illegible]	[illegible]	1.17	1.05	1.11	[illegible]
1.15	1.11	1.11	1.07	1.04	[illegible]
1.11	1.11	1.16	1.13	1.11	[illegible]
1.05	1.13	1.15	1.09	1.11	1.21
1.11	1.22	1.09	1.09	1.11	[illegible]
1.09	1.12	1.11	1.08	1.0[illegible]	1.12
1.11	1.12	1.10	1.12	1.12	[illegible]
1.11	1.13	1.13	1.12	1.09	[illegible]
1.14	1.12	1.13	1.15	1.15	[illegible]
1.16	1.16	1.18	1.16	1.1[illegible]	[illegible]
1.20	1.19	1.20	1.21	1.21	[illegible]
1.21	1.21	1.19	1.19	1.20	[illegible]
1.21	1.21	1.20	1.21	1.20	[illegible]
1.20	1.20	1.21	1.19	1.21	[illegible]

MEAN OF RMS= 1.14

TIME ON TARGET (SECS)

0.49	0.84	1.56	2.38	3.41	[illegible]
5.39	6.48	7.46	8.51	[illegible]	[illegible]
10.80	11.76	[illegible]	13.59	14.01	[illegible]
15.54	16.31	[illegible]	17.[illegible]	[illegible]	[illegible]
20.15	21.22	21.52	22.52	23.54	[illegible]
25.59	26.09	27.03	28.09	29.13	[illegible]
30.66	31.37	32.17	33.10	34.05	[illegible]
34.93	35.38	36.93	37.49	38.47	[illegible]
40.42	40.78	41.62	42.37	43.38	[illegible]
44.56	45.14	45.08	45.[illegible]	46.78	[illegible]
47.62	47.58	47.64	48.07	49.74	[illegible]
49.71	50.54	51.74	52.48	53.61	[illegible]
54.62	55.67	56.67	57.73	57.83	[illegible]
59.53	60.54	61.29	61.41	62.47	[illegible]
64.47	65.47	66.48	67.52	67.65	[illegible]

MK test 4

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.07	1.11	1.00	1.7.	1.11	..
1.11	1.11	1.17	1.16	1.21	1.10
1.54	1.15	1.16	1.21	1.17	1.11
1.11	1.14	1.13	1.13	1.16	1.1
1.15	1.11	1.17	1.13	1.13	1.1
1.11	1.13	1.12	1.11	1.11	1.0
1.14	1.14	1.14	1.14	1.11	1.11
1.06	1.12	1.13	1.11	1.12	1.1
1.10	1.09	1.11	1.0	1.1	1.1
1.13	1.15	1.09	1.13	1.11	1.10
1.15	1.14	1.13	1.13	1.15	1.14
1.12	1.13	1.13	1.11	1.12	1.1
1.12	1.12	1.13	1.14	1.14	1.14
1.13	1.13	1.12	1.11	1.1	..
1.07	1.13	1.11	1.12	1.13	1.14

MEAN OF RMS= 1.11

TIME ON TARGET (SECS)

0.76	1.80	2.7.	2.93	5.81	..
5.68	5.73	..	6.30	7.45	7.
9.01	10.01	10.9	11.26	12.24	12.
14.24	15.26	16.31	17.33	19.33	1 .
18.96	19.96	20.97	21.99	23.03	2 .
24.87	25.88	26.87	27.98	28.94	2 .
29.97	30.99	32.04	33.03	35.75	3 .
34.98	35.33	36.23	37.15	38.17	3 .
39.92	40.98	41.94	42.46	42.54	4 .
44.59	45.62	46.61	47.32	48.63	4 .
48.85	49.82	50.82	51.51	52.38	5 .
54.41	55.42	56.38	57.38	57.67	. .
59.42	60.48	61.54	61.54	62.50	. .
64.50	65.55	66.53	66.03	67.86	. .
69.91	70.92	71.96	72.18	72.93	7. .

MK test 5

ROLL
SUM OF SINE WAVES FUNCTIO.

RMS VALUE OF ERROR

3.23	2.73	1.81	1.85	1.87	1.77
1.73	1.57	1.57	1.53	1.45	1.50
1.41	1.36	1.37	1.30	1.29	1.28
1.30	1.29	1.28	1.29	1.29	1.27
1.23	1.27	1.26	1.27	1.23	1.25
1.26	1.24	1.25	1.25	1.28	1.23
1.24	1.25	1.27	1.24	1.25	1.23
1.21	1.24	1.23	1.21	1.20	1.23
1.20	1.22	1.22	1.22	1.23	1.21
1.23	1.19	1.21	1.18	1.20	1.19
1.20	1.19	1.18	1.19	1.18	1.20
1.19	1.18	1.20	1.18	1.18	1.19
1.19	1.19	1.19	1.18	1.19	1.19
1.18	1.16	1.17	1.17	1.18	1.19
1.17	1.16	1.16	1.17	1.16	1.19

MEAN OF RMS= 1.23

TIME ON TARGET (SECS)

0.00	0.14	1.14	2.16	3.21	4.01
5.05	6.05	7.04	7.96	8.14	9.11
10.14	11.18	12.18	12.51	14.34	15.33
14.70	15.73	16.69	17.74	17.96	18.99
19.55	20.58	21.59	22.60	23.60	24.53
24.43	25.10	26.15	27.14	27.68	28.57
29.00	30.00	31.05	32.05	32.94	33.99
33.82	34.90	35.86	36.85	37.00	38.03
39.07	40.05	41.02	42.06	42.44	43.47
43.88	44.16	45.19	46.18	46.55	47.57
48.27	49.58	50.41	51.42	52.44	53.42
54.34	55.11	55.97	57.02	57.54	57.72
58.71	59.74	60.77	61.75	62.78	63.78
64.52	65.50	66.55	67.18	67.55	68.58
69.07	69.07	70.07	70.67	71.41	72.42

MK test 6

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

0.00	2.25	1.70	1.48	1.36	1.37
1.33	1.18	1.23	1.22	1.20	1.24
1.27	1.19	1.25	1.21	1.14	1.18
1.17	1.24	1.15	1.16	1.11	1.17
1.16	1.13	1.11	1.11	1.13	1.13
1.09	1.11	1.13	1.11	1.16	1.11
1.10	1.11	1.10	1.08	1.08	1.07
1.07	1.07	1.07	1.08	1.08	1.09
1.08	1.09	1.06	1.10	1.05	1.07
1.07	1.09	1.05	1.05	1.07	1.05
1.07	1.06	1.07	1.07	1.04	1.04
1.05	1.06	1.06	1.03	1.06	1.04
1.05	1.05	1.06	1.04	1.06	1.03
1.06	1.05	1.05	1.05	1.03	1.04
1.05	1.06	1.05	1.07	1.05	1.02

MEAN OF RMS= 1.12

TIME ON TARGET (SECS)

0.96	0.98	1.63	2.60	3.63	4.61
5.64	6.45	6.80	7.63	8.85	9.68
10.61	11.40	12.25	13.24	14.25	15.25
16.23	16.95	18.01	18.99	20.01	21.00
22.02	23.03	23.57	24.10	25.03	26.12
27.12	28.17	29.14	30.14	31.08	32.13
33.17	34.15	35.16	36.20	37.20	38.22
39.23	40.22	41.24	42.26	43.23	44.23
44.94	45.61	46.57	47.61	48.61	49.63
50.66	51.67	52.67	53.69	54.65	55.65
56.67	57.66	58.74	59.72	60.71	61.75
62.71	63.72	64.73	65.76	66.75	67.77
68.80	69.81	70.80	71.23	72.27	73.27
73.63	74.62	75.63	76.62	77.62	78.62
79.63	80.61	81.70	82.67	83.71	84.71

M test 7

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

0.00	1.75	1.77	1.47	1.41	1.47
1.52	1.57	1.51	1.75	1.53	1.51
1.90	1.85	1.85	1.86	1.93	1.87
1.85	1.96	1.96	1.99	1.95	1.92
2.01	1.93	1.92	1.98	1.92	1.92
1.86	1.91	2.05	2.02	2.00	1.97
1.99	2.02	2.00	1.99	1.96	1.96
1.95	1.95	2.01	2.05	2.02	1.95
2.05	2.03	2.07	2.01	2.02	2.00
1.96	2.00	2.00	2.03	2.02	2.02
2.02	2.02	2.01	1.99	1.94	1.99
1.98	2.00	2.06	2.05	2.05	2.04
2.02	2.01	2.02	2.01	2.00	1.99
1.99	1.99	2.07	2.08	2.07	2.07
2.06	2.05	2.05	2.05	2.05	2.04

MEAN OF RMS= 1.98

TIME ON TARGET (SECS)

0.58	0.73	1.11	1.99	3.65	5.04
5.56	5.60	5.96	4.46	4.43	4.43
4.46	5.45	5.59	6.09	5.05	4.96
7.86	7.86	8.23	8.26	9.20	10.15
10.14	10.60	10.93	11.26	11.85	12.40
12.89	13.28	13.25	13.36	14.39	15.24
15.79	15.99	16.25	16.98	17.46	17.95
18.90	19.38	19.58	19.73	20.51	20.83
20.77	21.14	21.55	21.87	22.03	22.39
22.45	22.68	23.02	23.07	23.73	24.23
24.55	24.74	25.23	25.48	25.85	26.24
27.94	28.00	27.99	28.02	28.42	28.64
31.40	31.77	31.77	32.54	32.98	33.23
34.55	35.22	35.25	35.27	35.27	35.64
37.34	37.53	37.78	38.29	38.58	38.99

MK test 8

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.[illegible]	0.79	1.11	1.[illegible]	1.[illegible]	.[illegible]
1.65	1.66	1.[illegible]7	1.[illegible]1	1.67	1.[illegible]
1.77	1.63	1.72	1.[illegible]0	1.72	1.71
1.76	1.80	1.76	1.7[illegible]	1.71	1.7[illegible]
1.72	1.75	1.77	1.7[illegible]	1.77	1.7[illegible]
1.89	1.82	1.85	1.79	1.8[illegible]	1.[illegible]6
1.85	1.85	1.86	1.85	1.8[illegible]	1.[illegible]4
1.96	1.94	1.92	1.90	1.91	1.[illegible]3
1.94	1.92	1.93	1.91	1.92	1.[illegible]4
1.93	1.93	1.91	1.90	1.90	1.[illegible]8
1.87	1.88	1.89	1.87	1.86	1.[illegible]8
1.84	1.86	1.84	1.84	1.85	1.[illegible]5
1.83	1.82	1.82	1.81	1.82	1.[illegible]1
1.85	1.83	1.84	1.83	1.85	1.[illegible]2
1.85	1.82	1.81	1.81	1.80	1.[illegible]6

MEAN OF RMS= 1.83

TIME ON TARGET (SECS)

0.25	1.15	1.55	2.49	3.41	.[illegible]
4.00	4.44	5.05	5.46	5.[illegible]0	.[illegible]4
6.31	6.71	7.50	7.98	8.[illegible]5	.[illegible]3
9.41	9.89	10.51	11.31	11.[illegible]6	1.[illegible]
12.71	13.01	13.10	14.01	14.[illegible]5	1.[illegible]1
15.28	15.81	16.78	17.81	18.[illegible]9	1.[illegible]3
18.76	18.94	19.45	19.95	20.4[illegible]	.[illegible]
20.95	21.27	22.15	22.75	23.0[illegible]	.[illegible]3
23.62	24.03	24.44	25.45	2[illegible].2[illegible]	.[illegible]2
26.65	27.02	28.03	28.07	2[illegible].1[illegible]	.[illegible]5
30.07	30.68	30.92	31.90	32.[illegible]9	1.[illegible]7
33.13	33.07	34.12	35.12	35.[illegible]4	.[illegible]3
36.17	37.02	37.05	38.02	38.7[illegible]	.[illegible]
39.43	39.58	39.60	39.62	40.0[illegible]	.[illegible]5
40.42	41.32	42.06	43.04	4[illegible].7[illegible]	.[illegible]3

MK test 9

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.15	1.11	1.11	1.77	1.11	[illegible]
1.03	1.11	1.17	1.15	1.20	1.21
1.15	1.18	1.07	1.18	1.23	1.17
1.27	1.24	1.21	1.20	1.24	1.[illegible]
1.25	1.27	1.26	1.27	1.15	1.[illegible]
1.21	1.25	1.22	1.30	1.32	1.31
1.34	1.37	1.37	1.38	1.45	1.45
1.42	1.44	1.42	1.48	1.47	1.[illegible]
1.48	1.45	1.45	1.46	1.48	1.47
1.45	1.44	1.44	1.48	1.48	1.47
1.47	1.46	1.43	1.47	1.47	1.[illegible]
1.45	1.47	1.47	1.53	1.51	1.[illegible]
1.50	1.51	1.53	1.50	1.51	1.[illegible]
1.51	1.51	1.51	1.50	1.49	[illegible]
1.49	1.49	1.50	1.49	1.48	1.[illegible]

MEAN OF RMS= 1.39

TIME ON TARGET (SECS)

1.00	1.95	2.98	3.08	3.93	[illegible]
5.93	6.65	6.85	7.45	8.49	[illegible]
10.55	10.78	11.83	11.96	12.33	13.[illegible]
14.31	15.58	15.60	16.28	16.31	17.[illegible]
17.41	18.46	19.31	20.19	20.51	21.[illegible]
22.54	23.45	24.07	24.12	24.76	25.[illegible]
25.89	26.12	26.80	26.80	27.62	[illegible]
29.38	30.47	31.37	31.32	31.99	32.[illegible]
33.15	33.87	34.36	34.80	35.25	35.[illegible]
36.35	36.80	37.27	37.57	37.92	38.[illegible]
39.37	40.38	40.55	41.00	41.44	41.[illegible]
42.53	42.99	43.46	[illegible]	44.46	44.[illegible]
45.43	45.54	45.74	46.02	46.66	47.[illegible]
48.06	48.37	48.76	49.55	50.38	51.[illegible]
51.69	52.48	52.56	53.62	54.41	54.[illegible]

NK test 10

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

2.24	1.11	1.07	1.47	0.[illegible]	.[illegible]
1.32	1.30	1.33	1.21	1.16	1.[illegible]
1.23	1.18	1.16	1.21	1.20	1.17
1.16	1.16	1.16	1.15	1.15	1.20
1.29	1.21	1.24	1.22	1.27	1.[illegible]1
1.18	1.21	1.22	1.27	1.21	1.[illegible]1
1.24	1.26	1.22	1.26	1.31	1.[illegible]2
1.31	1.27	1.26	1.29	1.30	1.[illegible]4
1.33	1.33	1.33	1.32	1.33	1.31
1.30	1.29	1.28	1.29	1.28	1.31
1.32	1.31	1.32	1.31	1.30	1.31
1.30	1.29	1.28	1.29	1.28	1.[illegible]7
1.33	1.34	1.33	1.33	1.31	1.[illegible]2
1.31	1.31	1.32	1.31	1.30	1.31
1.30	1.30	1.30	1.30	1.28	1.[illegible]0

MEAN OF RMS= 0.96

TIME ON TARGET (SECS)

0.06	0.91	1.74	2.13	2.[illegible]	[illegible].[illegible]
4.85	5.88	6.91	7.[illegible]8	[illegible].71	[illegible].[illegible]0
9.86	10.91	11.94	12.[illegible]3	13.[illegible]4	14.[illegible]4
15.71	16.75	17.13	17.[illegible]3	18.[illegible]2	1[illegible].[illegible]1
18.96	19.96	20.41	20.[illegible]5	21.60	[illegible].[illegible]
23.57	24.19	24.53	24.[illegible]8	25.[illegible]2	[illegible].[illegible]
27.89	28.90	29.92	29.[illegible]8	30.63	[illegible].[illegible]0
31.04	32.07	33.07	33.20	33.[illegible]9	[illegible].[illegible]
34.67	35.69	36.37	37.[illegible]8	38.[illegible]9	[illegible].[illegible]3
40.22	41.23	42.28	43.26	44.21	44.[illegible]1
44.31	45.32	46.24	47.22	48.[illegible]2	[illegible].[illegible]
49.89	50.86	51.74	51.[illegible]8	53.[illegible]1	[illegible].[illegible]
53.25	53.26	54.12	55.14	56.17	[illegible].17
58.17	59.06	60.09	61.13	61.[illegible]2	[illegible].[illegible]0
63.20	64.20	65.02	65.[illegible]8	66.[illegible]0	[illegible].[illegible]9

MK test 1.13

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.17	1.[illegible]2	1.[illegible]	[illegible]79	1.[illegible]3	[illegible]93
1.1[illegible]	1.24	1.17	1.[illegible]8	1.16	[illegible]93
1.19	1.32	1.25	1.[illegible]7	1.20	[illegible]01
1.19	1.16	1.21	1.11	1.13	[illegible]05
1.17	1.17	1.17	1.[illegible]7	1.11	1.14
1.16	1.16	1.[illegible]3	1.17	1.14	1.17
1.14	1.15	1.15	1.11	1.17	1.[illegible]4
1.15	1.08	1.13	1.12	1.15	1.11
1.10	1.14	1.12	1.12	1.12	1.11
1.11	1.12	1.11	1.10	1.10	1.10
1.10	1.09	1.15	1.12	1.15	1.1[illegible]
1.12	1.14	1.13	1.12	1.14	1.12
1.12	1.11	1.12	1.11	1.11	1.[illegible]
1.11	1.10	1.12	1.11	1.14	1.1[illegible]
1.14	1.13	1.12	1.14	1.14	1.1[illegible]

TIME ON TARGET (SECS)

0.51	0.91	1.91	2.93	3.9[illegible]	[illegible]73
5.00	6.33	7.84	8.[illegible]6	[illegible]83	[illegible]
9.51	9.54	10.44	11.43	12.[illegible]6	[illegible]
13.89	14.69	15.[illegible]0	15.[illegible]9	17.88	[illegible]
19.91	20.88	21.89	21.[illegible]7	22.[illegible]2	[illegible]
25.75	24.50	25.27	25.74	25.[illegible]0	[illegible]
28.04	28.87	29.57	30.[illegible]5	31.60	[illegible]
35.20	34.28	35.28	35.28	37.50	[illegible]
39.19	39.37	40.38	41.39	41.[illegible]	[illegible]
45.69	44.69	45.72	46.76	47.74	[illegible]
49.24	50.26	50.54	51.04	51.12	[illegible]
52.77	53.79	54.78	55.79	56.78	[illegible]
58.86	59.52	60.48	61.42	62.47	[illegible]
64.00	64.98	65.05	65.02	66.10	[illegible]
68.63	67.23	67.85	68.75	69.[illegible]	[illegible]

MK test 12

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.[illegible]	1.38	0.91	1.[illegible]	1.[illegible]	[illegible]
1.19	1.11	1.[illegible]	1.[illegible]	1.1[illegible]	1.1[illegible]
1.0[illegible]	1.15	1.1[illegible]	1.07	1.07	1.11
1.08	1.05	1.0[illegible]	1.[illegible]	1.08	1.[illegible]
1.06	1.02	1.13	1.13	1.1[illegible]	1.[illegible]
1.18	1.17	1.17	1.19	1.18	1.[illegible]
1.19	1.22	1.22	1.20	1.17	1.[illegible]
1.21	1.19	1.17	1.19	1.19	1.[illegible]
1.1[illegible]	1.15	1.17	1.14	1.1[illegible]	1.[illegible]
1.1[illegible]	1.17	1.1[illegible]	1.1[illegible]	1.1[illegible]	1.[illegible]
1.1[illegible]	1.1[illegible]	1.1[illegible]	1.17	1.1[illegible]	1.17
1.17	1.17	1.1[illegible]	1.1[illegible]	1.1[illegible]	1.1[illegible]
1.16	1.14	1.17	1.1[illegible]	1.1[illegible]	1.1[illegible]
1.1[illegible]	1.14	1.14	1.14	1.1[illegible]	1.1[illegible]
1.14	1.13	1.14	1.1[illegible]	1.1[illegible]	1.[illegible]

MEAN OF RMS= 1.12

TIME ON TARGET (SECS)

0.31	1.31	2.3[illegible]	2.[illegible]	3.2[illegible]	[illegible]
5.24	6.28	7.26	8.[illegible]	[illegible]	1[illegible]
11.35	12.38	13.[illegible]	14.[illegible]	1[illegible]	1[illegible]
1[illegible]	1[illegible]	1[illegible]	18.[illegible]	1[illegible]	[illegible]
22.0[illegible]	23.02	23.[illegible]	23.[illegible]	24.[illegible]	[illegible]
2[illegible]	2[illegible]	27.19	27.[illegible]	[illegible]	[illegible]
2[illegible]	2[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

MK test 13

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.15	1.37	1.38	1.29	1.00	1.11
1.12	1.25	1.28	1.17	1.11	1.37
1.07	1.15	1.00	1.15	1.05	1.22
1.05	1.06	1.00	1.01	1.01	1.09
1.04	1.07	1.05	1.01	1.05	1.07
1.05	1.02	1.01	1.08	1.02	1.02
1.00	1.00	1.02	1.01	1.01	1.02
1.02	1.01	1.02	0.97	1.01	1.09
1.00	0.99	1.02	1.01	0.99	1.02
1.04	0.99	1.00	1.00	1.01	1.02
1.00	1.00	1.01	0.99	0.99	1.02
1.01	1.00	1.01	1.00	1.04	1.02
1.05	1.02	1.01	1.05	1.05	1.02
1.02	1.01	1.05	1.01	1.01	1.02
1.02	1.01	1.01	1.02	1.05	1.02

MEAN OF RMS= 1.03

TIME ON TARGET (SECS)

0.58	1.58	2.60	3.61	4.58	5.64
6.65	7.68	8.65	9.64	10.65	11.69
12.75	13.71	14.71	15.74	16.58	17.66
18.41	19.41	20.59	21.42	22.06	23.12
24.08	25.12	26.12	27.12	28.15	29.15
30.16	31.17	32.14	33.17	34.18	35.12
36.24	37.20	38.25	39.27	40.24	41.25
42.26	43.27	44.31	45.22	46.32	47.29
43.34	49.34	50.33	51.33	52.32	53.3
54.38	55.38	56.41	57.28	57.93	59.1
59.99	61.01	62.05	63.35	63.25	64.17
65.22	66.23	67.25	68.26	69.25	70.3
70.22	71.23	72.23	73.25	73.80	74.21
75.83	76.85	77.85	78.42	79.85	80.17
81.87	82.87	83.91	84.91	85.90	86.9

MK test 14

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

2.77	1.57	1.12	1.25	1.22	[illegible]
1.05	1.04	1.05	1.11	1.16	[illegible]
1.07	1.03	1.08	0.96	1.05	[illegible]
0.99	0.96	1.05	1.01	1.01	[illegible]
1.04	1.02	1.03	1.01	0.97	1.00
1.02	1.00	1.01	1.01	0.98	[illegible]
1.02	0.95	1.01	1.00	1.01	[illegible]
0.96	0.99	1.01	0.97	0.99	[illegible]
1.00	1.00	0.99	1.00	0.99	1.00
0.98	1.01	1.01	0.98	0.99	[illegible]
1.01	1.02	1.00	0.96	1.02	1.00
1.00	1.00	1.00	0.99	1.01	[illegible]
0.99	1.01	0.99	1.01	0.97	[illegible]
0.99	1.01	1.00	1.00	1.02	[illegible]
1.00	1.00	1.01	1.02	1.01	[illegible]

MEAN OF RMS= 1.00

TIME ON TARGET (SECS)

0.58	1.58	2.58	3.58	4.60	[illegible]
6.61	7.58	8.63	9.58	10.63	11.58
12.66	13.68	14.71	15.71	16.76	17.71
18.70	19.25	20.29	21.28	22.28	[illegible]
24.30	25.35	26.52	27.55	28.57	[illegible]
30.37	31.37	32.36	33.40	34.35	[illegible]
36.39	37.40	38.43	39.43	40.43	[illegible]
42.47	43.46	44.51	45.49	46.56	[illegible]
48.55	49.52	50.54	51.56	52.56	[illegible]
54.57	55.62	56.61	57.56	58.61	[illegible]
59.71	60.67	61.71	62.66	63.73	[illegible]
65.72	66.50	67.47	68.43	69.58	[illegible]
71.51	72.53	73.52	74.57	75.57	[illegible]
77.60	78.52	79.22	80.22	81.23	[illegible]
85.12	85.50	84.45	85.49	86.50	[illegible]

MM test 1

ROLL
STATION SIDE WAVES FUNCTION

RMS VALUE OF [illegible]

1.5[illegible]	1.59	1.56	1.47	1.41	1.44
1.26	1.47	1.48	1.52	1.21	1.[illegible]
1.54	1.56	1.51	1.[illegible]	1.[illegible]	1.[illegible]
1.22	1.[illegible]	1.[illegible]	1.[illegible]	1.[illegible]	1.[illegible]
1.23	1.23	1.24	1.20	1.20	1.[illegible]
1.17	1.16	1.15	1.17	1.1[illegible]	1.[illegible]
1.20	1.22	1.22	1.21	1.21	1.[illegible]
1.24	1.23	1.21	1.19	1.2[illegible]	1.[illegible]
1.25	1.21	1.25	1.22	1.24	1.25
1.22	1.25	1.25	1.25	1.24	1.[illegible]
1.26	1.25	1.24	1.25	1.25	1.[illegible]
1.24	1.24	1.25	1.21	1.25	1.[illegible]
1.25	1.24	1.27	1.25	1.24	1.[illegible]
1.24	1.25	1.26	1.[illegible]	1.25	1.[illegible]
1.25	1.22	1.25	1.22	1.[illegible]	1.[illegible]

MEAN OF RMS= 1.24

TIME ON TARGET (SECS)

0.24	1.34	1.55	1.71	2.7[illegible]	[illegible]
4.43	4.86	5.45	6.43	7.54	[illegible]
8.20	9.21	10.25	11.[illegible]	1[illegible]	[illegible]
13.39	14.91	15.95	16.[illegible]	17.2[illegible]	17.[illegible]
18.10	19.08	20.14	21.13	22.1[illegible]	[illegible]
23.07	24.09	25.72	[illegible].70	27.[illegible]	[illegible]
28.25	35.29	29.27	29.[illegible]	3[illegible].[illegible]	[illegible]
31.33	31.60	32.[illegible]	33.[illegible]	[illegible]	[illegible]
35.17	35.19	37.[illegible]	38.12	39.4[illegible]	[illegible]
40.37	41.32	42.39	43.[illegible]	44.2[illegible]	[illegible]
44.52	45.51	46.58	47.54	48.51	[illegible]
47.82	50.52	51.[illegible]	52.[illegible]	53.04	[illegible]
53.72	54.24	55.25	56.[illegible]	57.2[illegible]	[illegible]
57.83	58.79	61.04	62.[illegible]	63.[illegible]	[illegible]
64.00	65.00	66.28	67.00	67.5[illegible]	[illegible]

MM test 2

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.77	1.11	1.44	1.11	1.51	[illegible]
1.11	1.04	0.96	1.27	1.08	[illegible]
1.15	1.03	1.07	1.07	1.09	1.11
1.05	1.05	1.23	1.09	1.05	[illegible]
1.06	1.09	1.02	1.03	1.07	[illegible]
1.05	1.06	1.07	1.06	1.05	[illegible]
1.05	1.06	1.06	1.07	1.07	[illegible]
1.06	1.05	1.05	1.07	1.07	[illegible]
1.12	1.10	1.10	1.04	1.07	[illegible]
1.07	1.05	1.09	1.07	1.09	[illegible]
1.05	1.07	1.06	1.06	1.05	[illegible]
1.06	1.07	1.06	1.06	1.07	[illegible]
1.07	1.07	1.07	1.06	1.06	[illegible]
1.07	1.07	1.07	1.07	1.07	[illegible]
1.08	1.07	1.06	1.07	1.06	1.07

MEAN OF RMS= 1.07

TIME ON TARGET (SECS)

0.50	1.29	2.51	3.50	5.45	[illegible]
5.56	6.49	7.45	8.24	[illegible]	[illegible]
11.63	12.56	13.66	14.56	15.55	[illegible]
17.55	18.65	19.70	20.70	21.51	[illegible]
22.45	22.45	25.33	24.54	[illegible]	[illegible]
27.58	28.42	29.44	30.45	31.45	[illegible]
33.45	34.47	35.14	35.22	37.1[illegible]	[illegible]
39.23	40.27	41.27	42.02	[illegible]	[illegible]
44.21	45.33	46.32	47.42	47.27	[illegible]
44.32	49.38	50.39	51.34	52.21	[illegible]
54.23	55.26	56.26	[illegible]	58.27	[illegible]
60.03	61.02	62.06	[illegible]	63.86	[illegible]
65.33	66.37	66.51	67.55	68.65	[illegible]
70.67	71.71	72.71	73.78	74.25	[illegible]
75.31	76.28	77.35	78.35	79.36	[illegible]

MM test 3

KOLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.00	1.56	1.11	1.11	[illegible]	[illegible]
1.11	0.98	0.98	1.11	[illegible]	[illegible]
1.02	0.98	0.91	1.11	[illegible]	[illegible]
1.05	1.05	1.00	[illegible]	[illegible]	[illegible]
1.04	1.04	1.02	[illegible]	[illegible]	[illegible]
1.02	1.00	1.00	[illegible]	[illegible]	[illegible]
1.00	0.99	1.00	[illegible]	[illegible]	[illegible]
1.00	1.02	0.99	[illegible]	[illegible]	[illegible]
1.05	1.00	1.01	[illegible]	[illegible]	[illegible]
1.01	1.02	1.00	[illegible]	[illegible]	[illegible]
1.00	1.05	1.00	[illegible]	[illegible]	[illegible]
1.05	1.00	1.02	[illegible]	[illegible]	[illegible]
1.03	1.00	1.05	[illegible]	[illegible]	[illegible]
1.02	1.01	1.01	[illegible]	[illegible]	[illegible]
1.02	1.05	1.02	[illegible]	[illegible]	[illegible]

MEAN OF RMS= 1.01

TIME ON TAPE (SEC)

0.95	2.01	5.01	[illegible]	[illegible]	[illegible]
7.05	9.11	9.08	[illegible]	[illegible]	[illegible]
12.49	13.50	14.45	[illegible]	[illegible]	[illegible]
18.56	19.55	20.57	[illegible]	[illegible]	[illegible]
24.59	25.05	25.55	[illegible]	[illegible]	[illegible]
30.65	31.47	32.50	[illegible]	[illegible]	[illegible]
36.55	37.54	38.57	[illegible]	[illegible]	[illegible]
42.64	43.56	44.56	[illegible]	[illegible]	[illegible]
48.07	49.08	50.12	[illegible]	[illegible]	[illegible]
54.16	55.14	56.16	[illegible]	[illegible]	[illegible]
60.27	60.28	61.32	[illegible]	[illegible]	[illegible]
65.55	66.57	67.56	[illegible]	[illegible]	[illegible]
71.45	72.25	73.25	[illegible]	[illegible]	[illegible]
77.07	77.55	78.58	[illegible]	[illegible]	[illegible]
82.26	83.31	84.30	[illegible]	[illegible]	[illegible]

MM test 4

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF [illegible]

1.60	1.58	1.12	1.17	1.[illegible]	1.11
1.11	1.04	0.9[illegible]	0.[illegible]	1.[illegible]	[illegible]
0.97	0.94	1.07	0.[illegible]	0.9[illegible]	1.01
0.95	0.96	1.00	1.[illegible]	[illegible]	[illegible]
0.97	1.02	0.93	1.01	1.0[illegible]	1.01
1.00	0.96	0.98	1.04	0.9[illegible]	[illegible]
0.95	1.02	0.99	0.[illegible]	[illegible]	[illegible]
0.99	0.99	0.96	0.[illegible]	0.97	1.00
0.96	0.94	0.99	0.97	[illegible]	[illegible]
0.99	0.97	0.91	1.[illegible]	1.0[illegible]	[illegible]
0.97	1.00	0.[illegible]	1.00	1.02	1.00
1.00	1.[illegible]	[illegible]	1.01	1.0[illegible]	1.01
1.02	1.01	1.02	[illegible]	[illegible]	[illegible]
1.01	1.01	1.01	0.[illegible]	1.[illegible]	[illegible]
1.01	0.99	1.01	1.00	0.[illegible]	1.01

MEAN OF RMS = 0.99

TIME ON TARGET (SEC)

0.[illegible]	1.98	5.00	5.[illegible]	[illegible]	[illegible]
7.03	7.94	8.56	9.[illegible]	10.11	[illegible]
12.59	13.66	14.58	15.[illegible]	1[illegible]	[illegible]
1[illegible]	19.75	20.75	21.77	2[illegible]	[illegible]
24.78	25.82	26.80	27.[illegible]	[illegible]	[illegible]
30.30	31.28	32.34	33.33	34.[illegible]	[illegible]
36.35	37.37	38.42	39.44	[illegible]	[illegible]
42.46	43.07	44.09	45.14	46.16	[illegible]
48.17	49.18	50.19	[illegible]	[illegible]	[illegible]
54.26	55.24	56.27	[illegible]	[illegible]	[illegible]
60.06	61.14	62.10	[illegible]	[illegible]	[illegible]
66.56	66.56	67.57	[illegible]	[illegible]	[illegible]
70.56	71.61	72.61	73.67	[illegible]	[illegible]
76.68	77.68	78.70	79.73	[illegible]	[illegible]
82.77	83.80	84.82	[illegible]	[illegible]	[illegible]

MM test 5

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

0.00	0.79	0.91	1.05	0.85	1.20
1.11	1.04	1.23	1.11	1.15	1.06
1.02	1.02	2.03	1.07	1.04	1.01
0.95	1.05	0.97	1.05	0.96	1.04
0.99	1.04	1.02	1.07	1.07	1.05
1.02	1.00	1.02	1.04	1.05	1.01
0.98	1.00	0.99	0.99	1.02	0.97
1.00	1.00	1.01	0.98	1.00	1.00
1.00	0.99	1.01	1.00	1.03	1.03
1.02	1.00	1.01	1.05	1.05	1.02
1.04	1.03	1.05	1.03	1.05	1.05
1.05	1.04	1.03	1.03	1.04	1.05
1.01	1.03	1.04	1.05	1.05	1.04
1.05	1.03	1.02	1.03	1.01	1.03
1.03	1.02	1.03	1.03	1.02	1.01

MEAN OF RMS= 1.03

TIME ON TARGET (SECS)

0.96	1.99	3.00	3.95	5.03	[illegible]
7.15	8.06	9.06	10.11	11.11	[illegible]
15.15	14.18	15.19	15.21	17.25	[illegible]
19.23	20.26	21.28	22.32	23.32	[illegible]
25.32	26.34	27.36	28.37	29.34	[illegible]
31.42	32.45	33.50	34.15	35.17	[illegible]
37.20	38.20	39.35	40.22	41.28	[illegible]
43.28	44.28	45.33	46.31	46.37	[illegible]
49.03	49.63	50.04	51.03	52.03	[illegible]
54.67	55.72	56.72	57.19	57.48	[illegible]
59.26	59.26	60.33	61.23	62.31	[illegible]
64.35	65.32	66.46	67.41	68.42	[illegible]
70.41	71.48	72.50	73.31	74.37	[illegible]
76.50	77.35	78.20	78.32	79.37	[illegible]
81.06	82.90	83.09	84.20	85.04	[illegible]

MM test 6

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.92	1.57	0.91	1.55	1.10	0.54
1.03	1.11	0.98	1.03	1.00	1.01
1.07	0.59	1.05	1.04	1.01	[illegible]
0.99	0.96	1.05	1.00	1.01	[illegible]
1.02	1.04	1.00	0.95	1.05	[illegible]
1.05	1.00	0.98	0.99	0.97	1.01
1.02	0.99	1.07	0.98	0.95	0.95
1.05	1.00	0.95	0.93	1.00	1.00
0.99	0.99	0.98	1.01	0.99	[illegible]
0.95	0.98	1.00	1.00	1.00	[illegible]
0.94	0.98	1.05	0.96	1.01	[illegible]
1.00	1.00	0.99	1.00	1.00	1.00
0.96	0.99	0.98	1.02	1.00	1.00
0.99	1.01	1.00	1.00	1.00	[illegible]
0.98	0.99	0.99	1.00	[illegible]	1.00

MEAN OF RMS= 1.00

TIME ON TARGET (SECS)

0.98	2.00	3.01	4.05	[illegible]	[illegible]
7.10	8.11	9.08	10.09	11.11	[illegible]
15.19	14.15	15.19	16.[illegible]1	17.21	[illegible]
19.26	20.24	21.26	22.32	23.30	[illegible]
25.33	25.73	[illegible]	27.72	28.74	[illegible]
30.75	31.77	32.78	33.[illegible]2	34.[illegible]	[illegible]
35.83	37.89	38.87	39.89	40.92	41.[illegible]
42.89	43.94	44.[illegible]1	45.[illegible]7	47.99	48.01
49.03	50.06	51.05	[illegible]	[illegible]	[illegible]
55.12	55.83	56.91	[illegible]	[illegible]	[illegible]
60.95	62.01	[illegible]	[illegible]	[illegible]	[illegible]
66.81	67.87	68.88	69.70	70.7[illegible]	[illegible]
72.71	73.78	74.75	75.90	76.81	[illegible]
78.22	79.26	80.26	81.27	[illegible]	[illegible]
84.27	85.35	86.34	87.36	88.36	[illegible]

MM test 7

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF [illegible]

1.50	1.77	1.57	1.[illegible]	1.57	1.[illegible]
0.59	1.30	0.98	1.[illegible]	1.[illegible]	1.[illegible]
1.27	1.26	1.16	1.29	1.26	1.17
1.17	1.56	1.08	1.11	1.1[illegible]	1.[illegible]
1.19	1.25	1.19	1.22	1.15	1.15
1.16	1.19	1.19	1.16	1.14	1.15
1.15	1.17	1.18	1.16	1.15	1.17
1.12	1.17	1.16	1.16	1.11	1.14
1.15	1.15	1.15	1.13	1.16	1.14
1.15	1.14	1.15	1.16	1.17	1.15
1.14	1.14	1.15	1.15	1.17	1.[illegible]
1.15	1.17	1.16	1.16	1.14	1.15
1.15	1.15	1.14	1.14	1.[illegible]	1.15
1.14	1.14	1.14	1.15	1.15	1.14
1.15	1.16	1.16	1.15	1.1[illegible]	1.14

MEAN OF RMS= 1.17

TIME ON TARGET (SECS)

0.54	1.28	1.29	1.[illegible]	[illegible]	[illegible]
4.91	5.95	6.98	7.[illegible]	[illegible]	[illegible]
10.71	11.71	12.15	12.[illegible]	13.31	[illegible]
15.51	16.58	17.58	18.56	19.[illegible]	[illegible]
20.55	20.55	20.76	21.76	22.7[illegible]	[illegible]
24.87	25.84	26.85	27.90	28.9[illegible]	[illegible]
30.94	31.05	31.05	32.15	33.1[illegible]	[illegible]
35.15	36.15	37.22	38.19	39.2[illegible]	[illegible]
41.26	42.29	43.26	44.23	44.25	[illegible]
45.54	46.61	47.61	48.54	48.56	[illegible]
50.35	51.36	52.21	52.56	53.54	[illegible]
55.54	56.57	57.61	58.65	59.61	[illegible]
61.65	61.82	62.81	62.95	63.53	[illegible]
65.56	66.40	67.41	68.45	69.45	70.47
71.47	72.56	72.58	73.58	74.[illegible]	[illegible]

MM test 8

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

0.00	1.37	0.91	1.24	1.11	1.16
1.11	1.24	1.05	1.11	1.21	1.06
1.11	1.07	0.99	1.11	1.11	1.11
1.06	1.05	1.06	1.08	0.96	1.01
1.04	1.04	1.02	1.07	1.07	1.07
1.07	1.09	1.06	1.06	1.05	1.01
1.06	1.08	1.08	1.07	1.05	1.07
1.06	1.03	1.03	1.06	1.06	1.02
1.05	1.11	1.05	1.04	1.06	1.07
1.07	1.06	1.06	1.06	1.0[illegible]	1.07
1.04	1.04	1.05	1.06	1.05	1.04
1.05	1.07	1.10	1.05	1.04	1.06
1.05	1.05	1.05	1.06	1.06	1.06
1.05	1.04	1.05	[illegible]	1.05	1.04
1.06	1.04	1.05	1.05	1.04	1.05

MEAN OF RMSE= 1.06

TIME ON TARGET (SECS)

0.96	1.48	2.76	3.75	4.91	[illegible].80
6.81	7.65	8.85	9.83	10.90	[illegible]
12.70	13.10	14.09	15.09	16.14	17.18
18.15	19.20	20.21	21.18	22.22	[illegible].28
24.24	24.39	25.14	26.23	26.17	[illegible].18
28.20	29.22	30.22	31.27	32.24	[illegible].32
34.22	35.24	36.45	36.30	37.30	[illegible].32
39.39	40.32	41.33	42.37	43.36	[illegible].38
45.25	45.52	46.51	47.53	48.56	[illegible].38
50.57	51.56	52.62	53.57	54.61	[illegible].57
56.68	57.67	58.56	58.65	59.55	[illegible].57
61.90	62.91	63.93	64.95	65.91	[illegible].91
67.65	68.23	69.07	70.16	71.16	[illegible].16
73.17	74.20	75.21	76.26	77.26	[illegible].27
73.88	79.78	80.76	81.78	82.81	[illegible].2

MM test 9

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.12	1.77	1.11	1.07	1.71	1.07
1.11	1.04	1.17	1.11	1.05	1.01
1.11	0.94	1.07	1.07	1.05	1.01
1.05	1.05	1.05	1.03	1.01	1.07
1.04	0.95	0.98	1.05	1.01	1.01
1.02	1.11	0.98	0.97	1.01	0.99
1.00	1.02	1.00	0.96	1.01	1.00
1.00	0.99	0.96	0.93	1.00	1.00
1.00	0.96	1.01	0.97	1.00	1.00
0.98	0.96	0.99	0.99	1.00	1.00
0.95	0.98	1.00	1.00	0.99	1.00
0.94	1.01	0.91	1.00	0.96	1.00
1.05	1.01	1.00	1.03	1.05	1.00
1.01	1.01	1.00	1.02	1.02	1.01
1.00	1.01	1.01	1.02	1.01	1.03

MEAN OF RMSE= 1.00

TIME ON TARGET (SECS)

0.50	1.29	2.50	3.50	4.50	5.50
6.56	7.40	8.56	9.41	10.45	11.47
12.48	13.48	14.51	15.51	16.54	17.54
18.60	19.59	20.65	21.65	22.51	23.57
24.65	25.52	26.53	27.54	28.52	29.53
30.57	31.50	32.62	33.65	34.58	35.47
36.67	37.70	38.69	39.72	40.73	41.72
42.77	43.74	44.81	45.84	46.85	47.88
48.69	49.69	50.71	51.72	52.71	53.72
54.96	55.18	55.96	57.01	57.01	58.02
60.07	61.11	62.07	63.05	64.12	65.13
66.17	67.17	68.18	69.18	70.17	71.17
71.06	71.95	72.18	73.21	74.22	75.25
76.25	77.27	78.26	79.31	80.25	81.26
82.35	83.39	84.36	85.40	86.39	87.44

MM test 10

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

2.77	2.65	2.51	2.39	1.74	1.75
1.75	1.62	1.57	1.53	1.50	1.49
1.41	1.33	1.46	1.41	1.55	1.55
1.27	1.26	1.28	1.25	1.31	1.26
1.25	1.25	1.24	1.24	1.21	1.23
1.23	1.21	1.20	1.16	1.23	1.25
1.20	1.21	1.19	1.19	1.20	1.19
1.20	1.15	1.18	1.19	1.19	1.14
1.21	1.16	1.14	1.17	1.11	1.15
1.15	1.18	1.17	1.16	1.11	1.17
1.17	1.17	1.17	1.15	1.15	1.15
1.17	1.15	1.14	1.15	1.15	1.15
1.15	1.15	1.15	1.14	1.14	1.14
1.15	1.09	1.14	1.14	1.13	1.15
1.11	1.14	1.15	1.15	1.11	1.11

MEAN OF RMSE= 1.20

TIME ON TARGET (SECS)

0.55	0.81	1.09	2.21	5.05	5.11
5.05	5.76	6.74	7.71	9.55	9.51
10.70	10.71	11.59	12.61	13.51	14.51
15.69	16.59	17.66	18.59	19.63	19.72
20.94	21.68	22.33	23.73	24.62	24.73
25.64	26.72	27.75	28.75	29.55	29.53
31.07	31.89	32.90	33.89	34.71	34.82
36.36	37.37	38.35	39.36	40.25	40.38
41.69	42.59	43.91	44.79	45.76	45.98
46.91	47.66	48.67	49.66	50.71	51.43
52.59	52.97	53.51	54.54	55.57	55.63
57.17	58.17	59.15	59.52	61.59	61.61
62.58	63.58	64.58	65.45	66.53	66.47
68.50	69.50	70.51	71.52	72.55	72.45
74.56	75.57	76.62	77.61	78.63	78.45

MM test 11

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.58	1.93	0.91	1.24	0.86	[illegible]
1.11	0.96	1.17	0.99	1.02	[illegible]
0.87	1.15	1.11	1.07	1.04	[illegible]
1.11	1.05	1.11	1.13	[illegible]	[illegible]
1.02	1.04	0.96	1.01	[illegible]	[illegible]
0.95	1.04	1.07	[illegible]	0.97	[illegible]
1.06	1.06	1.02	1.04	1.01	[illegible]
1.03	1.02	1.02	1.06	1.02	[illegible]
1.04	1.06	1.05	1.04	1.01	[illegible]
1.04	1.04	1.03	1.04	1.03	[illegible]
1.01	1.02	1.03	[illegible]	[illegible]	[illegible]
1.03	1.02	1.03	1.03	[illegible]	[illegible]
1.05	1.05	1.03	1.05	[illegible]	[illegible]
1.04	1.04	1.03	1.04	[illegible]	[illegible]
1.04	1.04	1.03	1.02	[illegible]	[illegible]

MEAN OF RMS= 1.04

TIME OR TARGET (SECS)

0.93	1.94	[illegible]	[illegible]	[illegible]	[illegible]
7.01	8.05	[illegible]	10.05	11.11	[illegible]
13.11	13.73	[illegible]	15.41	[illegible]	[illegible]
18.46	19.49	20.55	[illegible]	[illegible]	[illegible]
24.54	25.57	26.57	[illegible]	[illegible]	[illegible]
30.72	31.65	32.66	33.20	[illegible]	[illegible]
36.34	36.39	37.43	[illegible]	[illegible]	[illegible]
41.45	42.49	43.45	44.45	[illegible]	[illegible]
46.72	47.72	48.74	49.73	[illegible]	[illegible]
52.75	53.74	54.73	55.34	[illegible]	[illegible]
58.91	59.91	60.92	61.52	[illegible]	[illegible]
64.50	65.45	66.47	65.36	[illegible]	[illegible]
69.27	70.28	71.30	72.35	[illegible]	[illegible]
75.37	76.37	77.40	78.41	[illegible]	[illegible]
80.78	81.85	82.87	83.88	[illegible]	[illegible]

MM test 12

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.12	1.12	0.00	[illegible]	1.11	[illegible]
1.11	1.04	1.17	1.[illegible]	1.00	[illegible]
0.97	0.98	1.07	1.[illegible]	1.0[illegible]	1.01
0.99	1.08	1.0[illegible]	1.[illegible]	0.[illegible]	[illegible]
1.02	1.02	1.[illegible]	1.0[illegible]	1.0[illegible]	1.01
1.04	1.00	1.00	1.02	1.0[illegible]	1.[illegible]
1.05	1.00	1.04	1.02	0.[illegible]	[illegible]
1.03	1.06	1.[illegible]	1.[illegible]	1.[illegible]	[illegible]
1.03	1.02	1.03	1.03	1.04	[illegible]
1.02	1.04	1.02	1.[illegible]	[illegible]	[illegible]
1.02	1.02	1.00	1.03	1.00	[illegible]
1.03	1.03	1.01	1.[illegible]	1.[illegible]	[illegible]
1.02	1.01	1.02	1.02	1.0	[illegible]
1.02	1.03	0.[illegible]	[illegible]	1.[illegible]	[illegible]
1.01	1.01	1.02	1.00	1.02	1.01

MEAN OF RMSE 1.02

TIME ON TARGET (SEC)

0.98	1.98	2.00	3.[illegible]	[illegible]	[illegible]
7.10	8.11	9.11	10.13	11.1[illegible]	[illegible]
13.13	14.00	14.43	15.48	16.[illegible]	[illegible]
18.23	19.25	20.25	21.[illegible]	22.[illegible]	[illegible]
24.17	24.[illegible]	25.07	26.[illegible]	27.[illegible]	[illegible]
29.34	30.34	31.[illegible]	32.[illegible]	33.[illegible]	[illegible]
35.07	35.74	36.[illegible]	37.72	38.[illegible]	[illegible]
40.79	41.83	42.[illegible]	43.61	44.47	[illegible]
46.91	47.25	48.21	49.18	50.[illegible]	[illegible]
52.26	53.26	54.31	55.32	56.[illegible]	[illegible]
58.24	59.37	60.[illegible]	61.[illegible]	62.[illegible]	[illegible]
64.43	65.45	66.48	67.47	68.[illegible]	[illegible]
70.52	71.27	72.32	73.32	73.[illegible]	[illegible]
75.[illegible]	76.[illegible]	77.85	78.71	79.71	[illegible]
81.87	82.03	82.91	83.[illegible]	84.[illegible]	[illegible]

MM test 13

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.11	1.77	1.11	0.98	1.02	1.11
1.11	1.04	0.91	0.95	0.94	1.02
1.11	0.94	1.07	1.00	0.97	0.97
1.05	0.93	1.00	1.00	0.97	0.98
0.85	0.97	1.00	1.05	0.99	0.97
1.00	0.96	0.97	0.97	1.01	0.97
1.00	1.02	0.99	0.91	0.96	0.98
0.96	0.97	0.96	0.97	0.96	0.97
0.98	0.98	0.97	0.97	1.03	0.98
0.97	0.96	0.96	0.98	0.95	0.97
0.97	0.96	0.97	0.96	0.97	0.96
0.97	0.99	0.99	0.97	0.96	.97
0.96	0.97	0.97	0.98	0.96	0.96
0.97	0.97	0.95	0.95	0.99	0.97
0.98	0.96	0.97	0.97	0.98	0.96

MEAN OF RMS= 0.98

TIME ON TARGET (SECS)

0.94	1.99	2.99	4.00	5.06	6.03
7.05	8.06	9.09	10.11	11.11	12.17
13.13	14.19	15.15	16.18	17.19	18.22
19.23	20.23	21.30	22.30	23.24	24.29
25.35	26.34	27.39	28.37	29.38	30.42
31.42	32.43	33.47	34.45	35.46	36.48
37.53	38.54	39.53	40.54	41.57	42.61
43.61	44.62	45.56	46.64	47.63	48.71
49.65	50.71	51.72	52.75	53.67	54.77
55.58	56.61	57.65	58.67	59.64	60.66
61.70	62.71	63.71	64.72	65.65	66.74
67.71	68.75	69.73	70.76	71.77	72.78
73.81	74.85	75.83	76.83	77.85	78.89
79.91	80.86	81.93	82.96	83.94	84.97
85.97	86.97	88.02	89.05	90.07	91.10

MM test 14

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.13	0.79	0.64	1.[illegible]4	1.2[illegible]	1.11
0.42	1.04	0.96	[illegible]	0.[illegible]	[illegible]
1.02	0.98	0.95	0.96	1.00	[illegible]
0.95	1.02	1.03	0.97	0.9[illegible]	[illegible]
0.97	1.02	1.00	0.93	0.97	[illegible]
1.02	1.02	0.96	0.97	0.9[illegible]	[illegible]
0.95	0.95	0.99	0.95	0.9[illegible]	[illegible]
0.96	0.96	0.96	0.97	0.94	[illegible]
0.93	0.97	0.97	0.96	0.9[illegible]	[illegible]
0.93	0.94	1.00	0.97	0.9[illegible]	[illegible]
0.95	0.96	0.96	0.[illegible]	0.9[illegible]	[illegible]
0.96	0.[illegible]	0.[illegible]	0.[illegible]	0.[illegible]	[illegible]
0.96	0.96	0.97	0.97	0.9[illegible]	[illegible]
0.96	0.96	0.[illegible]	0.[illegible]	[illegible]	[illegible]
0.[illegible]	0.[illegible]	0.[illegible]	0.97	0.91	[illegible]

MEAN OF RMS= 0.96

TIME ON TARGET (SECS)

0.95	1.94	2.98	4.01	5.0[illegible]	[illegible]
7.05	8.09	9.11	10.11	11.1[illegible]	[illegible]
13.14	14.19	15.19	16.23	17.23	[illegible]
19.23	20.26	21.32	22.36	23.32	[illegible]
25.34	26.37	27.35	28.42	29.40	[illegible]
31.42	32.47	33.45	34.47	35.50	[illegible]
37.55	38.58	39.57	40.[illegible]	41.5[illegible]	[illegible]
43.61	44.59	45.[illegible]	46.[illegible]	47.64	[illegible]
49.73	50.71	51.73	52.7[illegible]	53.79	[illegible]
55.79	56.82	57.83	58.83	59.8[illegible]	[illegible]
61.86	62.90	63.93	64.[illegible]	65.97	[illegible]
68.00	69.02	70.05	71.05	72.0[illegible]	[illegible]
74.07	75.11	76.07	77.11	78.1[illegible]	[illegible]
80.16	81.18	82.17	83.24	84.21	[illegible]
86.21	87.27	88.26	89.30	90.3[illegible]	1.3[illegible]

RL test 1

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.13	0.78	0.91	1.11	1.3[illegible]	[illegible]. 1
1.33	1.47	1.17	1.[illegible]0	1.[illegible]6	[illegible]
1.34	1.39	1.25	1.30	1.40	1.41
1.32	1.31	1.37	1.34	1.3[illegible]	1.[illegible]
1.42	1.40	1.33	1.3[illegible]	1.34	1.[illegible]5
1.32	1.30	1.35	1.[illegible]5	1.3[illegible]	1.34
1.37	1.31	1.33	1.34	1.31	1.[illegible]
1.30	1.35	1.30	1.[illegible]2	1.3[illegible]	[illegible]
1.37	1.36	1.34	1.34	1.3[illegible]	1.34
1.35	1.38	1.34	1.35	1.37	1.[illegible]
1.38	1.37	1.38	1.37	1.38	1.[illegible]
1.38	1.37	1.3[illegible]	1.[illegible]	1.37	1.37
1.37	1.36	1.37	1.38	1.3[illegible]	1.[illegible]
1.[illegible]	1.37	1.37	1.37	1.37	1.[illegible]
1.35	1.35	1.3[illegible]	1.[illegible]	1.3[illegible]	1.[illegible]

MEAN OF RMS= 1.35

TIME ON TARGET (SECS)

1.00	1.46	2.[illegible]	[illegible].1[illegible]	[illegible].[illegible]	[illegible].[illegible]
4.85	5.94	7.01	7.[illegible]0	7.7[illegible]	[illegible].24
8.23	8.86	9.91	10.[illegible]1	11.0[illegible]	11.[illegible]
12.34	13.35	13.[illegible]9	14.[illegible]	14.[illegible]	[illegible].1[illegible]
16.61	16.[illegible]5	17.[illegible]3	17.[illegible]2	1[illegible].[illegible]	[illegible].7
20.03	21.03	22.02	22.[illegible]2	[illegible].7[illegible]	[illegible].1[illegible]
24.14	25.22	25.[illegible]7	25.[illegible]3	27.54	[illegible].7
28.79	29.80	30.[illegible]5	31.24	31.[illegible]3	[illegible].[illegible]0
33.35	34.37	35.32	35.[illegible]4	[illegible].[illegible]5	[illegible].11
37.72	38.72	39.[illegible]3	40.07	40.17	[illegible].[illegible]2
41.9[illegible]	42.78	43.51	43.74	43.[illegible]7	[illegible].24
44.81	45.86	46.79	46.[illegible]5	47.57	[illegible].14
48.67	49.72	49.87	50.18	[illegible]0.61	[illegible].1
51.78	52.81	53.82	54.1[illegible]	54.7[illegible]	[illegible].[illegible]0
56.46	57.32	58.[illegible]9	59.[illegible]9	5[illegible].[illegible]	[illegible].15

RL test 2

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.57	1.77	1.44	0.97	1.31	1.10
1.19	1.04	0.91	0.[illegible]	1.54	1.02
1.02	1.11	1.11	1.21	1.21	1.17
1.17	1.14	1.16	1.[illegible]	1.20	[illegible]
1.13	1.15	1.19	1.15	1.07	1.1[illegible]
1.16	1.16	1.19	1.14	1.14	1.17
1.17	1.10	1.17	1.20	1.20	1.1[illegible]
1.15	1.18	1.17	1.19	1.1[illegible]	1.1[illegible]
1.17	1.15	1.14	1.1[illegible]	1.14	1.14
1.14	1.14	1.14	1.12	1.17	1.1[illegible]
1.14	1.16	1.17	1.17	1.17	1.1[illegible]
1.17	1.16	1.16	1.1[illegible]	1.1[illegible]	1.1[illegible]
1.16	1.16	1.18	1.1[illegible]	1.17	1.16
1.17	1.18	1.18	1.17	1.16	1.17
1.17	1.16	1.15	1.1[illegible]	1.1[illegible]	[illegible].17

MEAN OF RMS= 1.15

TIME ON TARGET (SECS)

0.94	1.39	2.16	3.1[illegible]	4.1[illegible]	[illegible].1[illegible]
6.21	6.51	7.53	8.54	[illegible].[illegible]	10.[illegible]1
11.58	12.61	12.9[illegible]	13.[illegible]8	14.31	1[illegible].[illegible]1
16.54	16.80	17.80	18.[illegible]3	19.11	[illegible].[illegible]8
21.12	21.47	21.97	23.02	23.[illegible]	[illegible].[illegible]5
26.05	27.03	27.38	28.34	29.0[illegible]	[illegible].19
31.14	31.79	32.04	32.49	33.20	[illegible].4
35.03	35.27	36.24	37.[illegible]	38.27	[illegible].4[illegible]
40.32	41.32	41.91	42.[illegible]7	43.[illegible]	[illegible].[illegible]7
46.03	46.38	43.01	48.67	4[illegible].[illegible]4	[illegible].[illegible]4
50.64	50.86	51.62	52.7[illegible]	53.[illegible]0	[illegible].[illegible]4
55.22	56.19	56.6[illegible]	58.82	57.[illegible]7	[illegible].[illegible]
59.67	60.29	60.71	61.34	62.[illegible]8	[illegible].[illegible]1
64.13	64.71	65.41	66.15	67.00	[illegible].47
69.00	69.67	69.87	70.[illegible]3	71.[illegible]7	[illegible].[illegible]

RL test 3

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.96	1.57	1.12	1.47	1.51	1.20
1.19	1.25	1.17	1.22	1.25	1.16
1.15	1.26	1.11	1.08	1.14	1.17
1.11	1.05	1.19	1.14	1.1[illegible]	1.1[illegible]
1.15	1.13	1.13	1.13	1.20	1.15
1.15	1.11	1.13	1.11	1.14	1.11
1.14	1.14	1.13	1.14	1.15	1.12
1.12	1.15	1.10	1.13	1.13	1.1[illegible]
1.14	1.16	1.15	1.17	1.16	1.16
1.20	1.17	1.16	1.18	1.17	1.16
1.18	1.17	1.15	1.15	1.15	1.14
1.17	1.17	1.16	1.17	1.19	1.18
1.17	1.17	1.17	1.17	1.20	1.19
1.18	1.18	1.18	1.1[illegible]	1.1[illegible]	1.1[illegible]
1.19	1.19	1.18	1.19	1.21	1.21

MEAN OF RMS= 1.16

TIME ON TARGET (SECS)

0.44	1.58	1.88	2.31	2.[illegible]	[illegible]
4.71	5.76	6.59	7.19	7.[illegible]	[illegible]
9.61	10.65	11.5[illegible]	12.19	12.[illegible]	13.75
14.66	15.66	16.41	16.[illegible]	17.19	1[illegible].16
19.18	20.20	20.29	20.7[illegible]	21.57	[illegible]
23.54	24.57	25.65	26.04	26.7[illegible]	[illegible]
28.40	29.33	30.08	30.[illegible]	31.1[illegible]	[illegible]
32.52	33.48	34.45	35.32	35.[illegible]	[illegible]
37.50	38.53	39.27	39.[illegible]	40.[illegible]	[illegible]
41.17	41.98	43.04	44.06	44.36	[illegible].11
46.12	47.08	48.14	49.03	49.[illegible]	[illegible].17
50.72	51.74	52.55	52.73	53.40	[illegible]
55.22	56.25	56.31	56.[illegible]	57.42	[illegible]
58.98	59.98	61.03	61.75	62.45	.91
63.50	64.61	65.15	65.61	66.79	[illegible].1

RL test 4

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.13	0.00	1.45	1.11	0.76	1.02
0.94	1.04	0.98	1.11	1.0[illegible]	1.0[illegible]
1.07	1.07	1.03	1.15	1.04	1.11
1.05	1.02	1.00	1.16	1.18	1.16
1.18	1.15	1.19	1.15	1.13	1.18
1.16	1.21	1.18	1.19	1.22	1.17
1.17	1.21	1.15	1.11	1.15	1.16
1.17	1.15	1.16	1.21	1.23	1.20
1.23	1.20	1.19	1.21	1.21	1.21
1.14	1.22	1.20	1.19	1.15	1.20
1.20	1.22	1.18	1.19	1.20	1.22
1.21	1.20	1.21	1.20	1.17	1.21
1.21	1.20	1.20	1.20	1.20	1.19
1.19	1.20	1.19	1.20	1.20	1.19
1.18	1.19	1.16	1.18	1.17	1.19

MEAN OF RMS= 1.17

TIME ON TARGET (SECS)

0.96	2.01	3.00	4.03	5.01	[illegible]
6.65	7.71	8.66	8.94	[illegible]	10.01
11.58	12.63	13.64	13.[illegible]	14.51	[illegible]
16.08	17.10	18.14	18.[illegible]	19.95	20.94
20.06	21.09	22.09	22.87	23.[illegible]	[illegible]
24.44	25.44	26.02	26.99	27.[illegible]	[illegible]
29.50	30.55	31.54	32.[illegible]	33.60	[illegible]
34.52	35.52	36.12	36.20	36.95	[illegible]
38.94	39.[illegible]	40.[illegible]	41.65	41.[illegible]	[illegible]
43.11	44.06	45.12	45.59	[illegible]	[illegible]
47.98	48.51	49.32	49.[illegible]	[illegible]	[illegible]
51.73	52.74	53.07	53.[illegible]	54.[illegible]	[illegible]
56.34	57.37	58.09	58.75	59.[illegible]	[illegible]
61.02	62.06	63.00	63.[illegible]	64.[illegible]	[illegible]
66.01	67.03	67.72	68.21	69.77	[illegible]

RL test 5

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.11	0.00	1.12	0.96	0.96	1.00
1.33	0.96	0.98	1.11	1.01	1.04
1.15	1.11	0.99	1.13	1.06	1.04
1.08	1.05	1.00	1.09	1.11	1.06
0.94	1.05	1.09	1.07	1.13	1.13
1.11	1.08	1.09	1.09	1.11	1.11
1.05	1.12	1.08	1.11	1.12	1.12
1.15	1.12	1.11	1.09	1.11	1.15
1.13	1.12	1.10	1.10	1.15	1.15
1.13	1.17	1.16	1.12	1.17	1.14
1.13	1.14	1.18	1.16	1.16	1.15
1.14	1.16	1.13	1.14	1.15	1.13
1.15	1.13	1.15	1.13	1.15	1.15
1.15	1.15	1.17	1.14	1.15	1.16
1.17	1.14	1.16	1.17	1.16	1.17

MEAN OF RMS= 1.12

TIME ON TARGET (SECS)

0.81	1.85	2.81	3.78	4.76	5.75
5.91	6.89	7.91	8.94	9.91	10.93
11.21	12.26	13.21	14.06	14.56	15.75
16.39	17.16	18.25	19.20	20.19	20.79
21.52	22.29	23.32	24.30	24.57	25.10
25.90	26.92	27.33	28.37	28.87	29.53
30.63	31.38	32.42	33.43	33.93	34.53
35.48	36.52	37.02	38.02	39.03	40.12
40.23	41.19	42.19	42.82	43.23	44.33
44.24	45.28	46.06	47.13	48.09	48.83
49.22	49.58	50.49	51.52	52.01	52.77
53.27	54.27	55.31	55.97	56.67	57.33
58.02	59.04	60.07	61.08	61.75	62.73
62.48	63.55	64.56	65.40	66.06	66.93
66.63	67.23	68.28	69.28	70.31	71.05

RL test 6

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.15	1.37	1.44	1.47	1.2[illegible]	[illegible].84
0.94	1.24	1.11	1.17	1.3[illegible]	1.[illegible]6
1.02	0.98	1.11	1.00	1.01	1.[illegible]2
1.06	1.02	1.06	1.05	1.01	1.[illegible]4
1.04	1.05	1.07	1.07	1.0[illegible]	1.[illegible]7
1.09	1.09	1.08	1.0[illegible]	1.0[illegible]	1.10
1.07	1.10	1.02	1.16	1.0[illegible]	1.14
1.12	1.10	1.09	1.07	1.11	1.1[illegible]
1.09	1.10	1.07	1.09	1.0[illegible]	1.[illegible]3
1.11	1.12	1.09	1.08	1.09	1.[illegible]7
1.09	1.11	1.15	1.09	1.06	1.11
1.14	1.10	1.09	1.10	1.10	1.[illegible]9
1.10	1.12	1.14	1.10	1.11	1.12
1.11	1.12	1.10	1.12	1.10	1.11
1.11	1.12	1.10	1.12	1.11	1.12

MEAN OF RMS= 1.09

TIME ON TARGET (SECS)

0.55	1.11	2.02	3.09	4.14	[illegible].16
6.20	7.26	8.28	9.24	10.24	1[illegible].28
11.66	12.66	13.68	14.65	15.71	1[illegible].71
17.71	18.54	19.41	20.41	21.45	[illegible].42
22.98	23.43	24.40	[illegible].47	25.27	[illegible].35
27.42	28.37	29.39	30.40	31.42	[illegible].43
32.75	33.50	34.52	35.[illegible]	36.[illegible]	[illegible].77
37.77	38.82	39.83	40.[illegible]	41.87	42.[illegible]7
43.13	45.67	44.72	45.72	46.[illegible]	[illegible].77
48.32	49.31	50.37	51.52	52.52	[illegible].1[illegible]
53.53	53.79	54.78	55.75	56.1[illegible]	[illegible].[illegible]7
57.92	58.91	59.92	[illegible].09	61.95	[illegible].[illegible]
63.41	63.96	64.6[illegible]	65.11	66.12	[illegible].[illegible]
67.61	68.47	69.50	70.52	71.53	[illegible].13
73.08	73.87	74.52	75.53	76.5[illegible]	77.[illegible]

RL test 7

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

2.74	2.25	1.70	1.47	1.58	1.43
1.40	1.63	1.70	1.61	1.42	1.47
1.54	1.49	1.52	1.50	1.4[illegible]	1.43
1.49	1.47	1.68	1.64	1.64	1.[illegible]8
1.68	1.69	1.67	1.64	1.66	1.64
1.60	1.63	1.63	1.61	1.59	1.63
1.70	1.66	1.66	1.63	1.64	1.61
1.61	1.65	1.65	1.61	1.64	1.60
1.60	1.60	1.61	1.62	1.59	1.63
1.59	1.60	1.64	1.64	1.66	1.64
1.64	1.64	1.65	1.63	1.62	1.62
1.62	1.59	1.62	1.61	1.62	1.59
1.66	1.65	1.66	1.65	1.64	1.64
1.62	1.62	1.63	1.62	1.62	1.62
1.65	1.65	1.63	1.64	1.64	1.64

MEAN OF RMS= 1.61

TIME ON TARGET (SECS)

0.00	0.81	1.79	2.75	3.81	4.34
5.29	5.46	5.61	6.93	7.93	7.93
9.09	9.59	9.61	10.78	11.31	11.78
12.46	12.96	12.95	13.80	14.51	14.65
15.03	15.24	16.24	17.13	17.13	17.[illegible]1
19.21	19.53	19.76	20.46	21.53	21.[illegible]0
21.92	22.68	23.65	24.60	25.58	25.[illegible]7
26.82	26.87	27.46	28.13	29.13	30.14
30.22	30.68	31.64	31.65	32.69	33.[illegible]1
33.70	34.05	35.99	35.02	36.07	36.[illegible]3
36.65	37.14	38.13	39.17	40.15	41.44
41.09	41.57	41.65	42.45	43.43	43.44
43.85	44.08	45.14	46.17	47.[illegible]	47.[illegible]4
48.22	48.21	48.81	49.61	50.59	51.14
51.18	51.63	52.33	52.[illegible]3	53.42	53.[illegible]4

RL test 8

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

0.00	2.10	1.11	1.57	1.52	1.02
1.19	1.24	1.17	1.52	1.21	1.[illegible]
1.41	1.49	1.55	1.44	1.[illegible]	1.[illegible]
1.44	1.47	1.48	1.52	1.45	1.47
1.49	1.41	1.39	1.41	1.41	1.[illegible]
1.35	1.42	1.40	1.41	1.3[illegible]	1.[illegible]
1.39	1.38	1.39	1.41	1.38	1.[illegible]
1.48	1.49	1.47	1.45	1.50	1.45
1.48	1.53	1.48	1.48	1.50	1.[illegible]0
1.53	1.51	1.51	1.51	1.50	1.[illegible]
1.48	1.50	1.50	1.46	1.4[illegible]	1.[illegible]
1.49	1.49	1.51	1.48	1.4[illegible]	1.[illegible]
1.47	1.46	1.49	1.[illegible]	1.4[illegible]	1.[illegible]
1.47	1.46	1.46	1.[illegible]	1.4[illegible]	1.47
1.46	1.46	1.47	1.46	1.4[illegible]	1.47

MEAN OF RMS= 1.45

TIME ON TARGET (SECS)

0.98	1.[illegible]0	2.06	3.[illegible]	[illegible].11	[illegible].1
5.61	6.10	6.28	7.09	[illegible].[illegible]	[illegible].[illegible]
8.88	9.14	9.35	10.[illegible]	11.04	11.[illegible]
11.78	12.09	13.10	14.11	14.[illegible]	1[illegible].43
15.91	16.34	16.90	17.43	18.[illegible]	19.[illegible]
19.55	20.26	20.62	21.[illegible]	22.[illegible]	[illegible].7
23.44	23.93	24.43	24.49	24.[illegible]	[illegible]
25.08	25.52	25.80	26.54	2[illegible].[illegible]	[illegible].[illegible]
28.47	28.75	29.74	30.04	31.04	[illegible].[illegible]
31.67	32.12	32.93	33.[illegible]	34.89	[illegible].[illegible]
36.54	36.63	37.63	38.[illegible]	39.[illegible]	[illegible].7
40.63	40.67	41.72	42.[illegible]	43.[illegible]	[illegible].[illegible]
44.98	45.66	46.06	47.[illegible]	47.[illegible]	[illegible]
48.61	49.11	49.47	50.[illegible]	51.56	[illegible].[illegible]
52.53	53.37	53.36	54.18	55.17	[illegible].[illegible]

RL test 9

ROLL

SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.96	1.37	1.12	0.78	1.20	1.20
1.39	1.11	1.28	1.11	1.25	1.25
1.27	1.11	1.31	1.21	1.14	1.28
1.22	1.24	1.21	1.25	1.29	1.34
1.31	1.25	1.33	1.31	1.29	1.40
1.46	1.45	1.46	1.46	1.41	1.43
1.40	1.42	1.40	1.38	1.42	1.40
1.39	1.44	1.42	1.39	1.41	1.41
1.41	1.42	1.36	1.41	1.41	1.41
1.39	1.38	1.41	1.42	1.47	1.43
1.42	1.42	1.41	1.41	1.36	1.44
1.45	1.43	1.42	1.44	1.43	1.43
1.46	1.44	1.44	1.44	1.44	1.43
1.44	1.43	1.42	1.43	1.43	1.43
1.44	1.44	1.43	1.43	1.43	1.43

MEAN OF RMS= 1.36

TIME ON TARGET (SECS)

0.41	0.96	2.04	2.99	3.28	3.71
4.36	5.39	6.41	7.41	8.01	8.43
9.68	10.86	11.83	12.28	12.78	13.55
13.75	14.31	15.33	15.75	16.28	16.81
17.58	17.78	18.28	19.19	19.79	19.79
20.09	20.75	21.77	22.78	23.08	23.38
25.09	25.65	26.02	27.02	27.19	27.92
28.58	29.04	30.04	30.49	31.26	31.83
32.24	32.67	33.65	33.98	34.43	35.17
36.15	36.79	37.24	37.52	37.77	38.02
39.82	40.23	41.29	42.31	43.01	43.72
43.94	44.58	45.59	46.22	46.57	46.79
47.66	48.71	49.69	50.33	50.43	50.77
51.94	52.68	53.37	53.92	53.98	54.02
55.61	56.18	57.17	57.54	57.64	57.79

RL test 10

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.13	2.10	1.08	1.47	1.58	1.45
1.39	1.24	1.28	1.51	1.34	1.32
1.27	1.26	1.16	1.21	1.23	1.14
1.25	1.31	1.13	1.13	1.18	1.15
1.17	1.15	1.15	1.18	1.13	1.16
1.14	1.16	1.16	1.12	1.17	1.06
1.19	1.18	1.19	1.21	1.22	1.18
1.19	1.20	1.14	1.18	1.20	1.15
1.17	1.17	1.15	1.18	1.15	1.15
1.18	1.17	1.16	1.15	1.17	1.16
1.20	1.19	1.13	1.17	1.17	1.17
1.15	1.16	1.17	1.15	1.17	1.17
1.15	1.15	1.16	1.16	1.14	1.13
1.16	1.15	1.14	1.16	1.16	1.15
1.15	1.14	1.16	1.15	1.14	1.14

MEAN OF RMS= 1.18

TIME ON TARGET (SECS)

0.81	1.16	1.05	1.41	1.53	1.42
4.43	5.41	6.46	7.49	8.01	8.51
9.53	10.28	11.08	11.95	12.65	13.17
14.66	15.68	16.68	17.55	18.58	19.14
19.84	20.79	21.15	21.53	22.64	23.15
24.63	25.68	26.64	26.53	28.95	29.39
28.45	29.45	30.16	30.40	31.37	32.02
33.07	34.08	35.07	35.76	36.82	37.78
38.62	39.52	40.85	41.42	42.82	43.27
44.26	45.48	46.37	47.08	47.76	48.34
48.76	49.81	50.54	51.42	51.53	52.17
53.53	54.58	55.44	56.17	56.53	57.42
58.36	59.42	60.52	60.51	61.56	62.42
63.32	64.03	65.01	65.33	66.46	67.44
68.52	69.42	70.21	70.56	71.62	72.17

RL test 11

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

2.76	1.92	1.70	1.47	1.37	1.20
1.45	1.30	1.43	1.36	1.40	1.45
1.34	1.51	1.37	1.27	1.29	1.35
1.25	1.26	1.16	1.15	1.15	1.20
1.17	1.23	1.17	1.22	1.15	1.19
1.15	1.16	1.17	1.19	1.17	1.17
1.17	1.21	1.19	1.16	1.17	1.17
1.15	1.18	1.17	1.17	1.18	1.17
1.19	1.19	1.19	1.18	1.15	1.20
1.16	1.17	1.16	1.15	1.21	1.17
1.18	1.19	1.16	1.17	1.19	1.15
1.18	1.17	1.19	1.15	1.15	1.17
1.20	1.16	1.14	1.17	1.20	1.17
1.19	1.19	1.21	1.17	1.17	1.19
1.19	1.18	1.16	1.18	1.17	1.16

MEAN OF RMS= 1.20

TIME ON TARGET (SECS)

0.19	1.25	2.25	3.21	4.23	5.01
5.15	6.16	7.24	7.95	8.83	9.77
9.94	10.93	11.89	12.83	13.93	14.94
15.34	16.09	17.06	18.09	19.10	20.15
20.46	21.39	22.34	23.40	24.3	25.39
25.39	26.39	26.59	27.55	28.53	29.75
29.27	30.27	31.25	32.30	33.35	34.37
35.32	36.05	37.04	37.74	37.93	38.45
38.47	39.29	40.30	41.33	42.35	43.47
43.87	44.36	45.16	46.19	47.22	47.35
47.89	48.39	49.38	50.35	50.97	51.36
52.67	53.63	54.12	55.12	56.03	56.27
57.61	58.32	59.32	60.41	60.61	61.35
62.55	62.55	62.91	63.56	63.85	64.06
65.36	66.35	67.37	68.42	69.35	70.20

RL test 12

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.14	1.37	1.10	0.57	0.86	1.11
1.05	0.96	0.98	1.05	1.00	1.0[illegible]
1.02	0.98	1.03	0.[illegible]8	1.04	[illegible]
1.09	1.08	1.03	1.05	[illegible]	1.01
1.02	1.09	1.04	0.[illegible]4	1.0[illegible]	[illegible]
1.05	1.07	1.09	1.07	1.0[illegible]	[illegible]
1.08	1.06	1.06	0.[illegible]9	1.04	[illegible]
1.04	1.06	1.05	1.0[illegible]	1.0[illegible]	[illegible]
1.11	1.04	1.05	1.05	[illegible]	1.05
1.05	1.00	1.05	1.05	1.05	[illegible]
1.04	1.05	1.03	1.02	1.00	[illegible]
1.02	1.01	1.05	1.02	1.01	1.02
1.05	1.02	1.02	1.02	1.02	[illegible]
1.01	1.05	1.05	1.05	1.0[illegible]	[illegible]
1.05	1.05	1.04	1.05	1.05	[illegible]

MEAN OF RMS= 1.05

TIME ON TARGET (SECS)

0.81	1.[illegible]8	2.61	3.54	4.[illegible]	[illegible]
6.66	7.69	8.49	9.[illegible]0	10.[illegible]	[illegible]
11.65	12.68	13.81	14.[illegible]5	15.[illegible]	[illegible]
17.61	18.35	19.58	20.57	21.[illegible]	[illegible]
23.59	23.87	24.52	25.90	2[illegible]	[illegible]
28.92	29.32	29.9[illegible]	30.94	31.97	[illegible]
33.99	34.99	35.98	[illegible]7.02	3[illegible]	[illegible]
40.05	41.05	42.04	[illegible]3.04	44.06	[illegible]
46.13	47.12	48.09	49.12	50.[illegible]	[illegible]
52.03	52.81	53.62	54.[illegible]	5[illegible]	[illegible]
57.67	58.68	59.72	60.72	[illegible]	[illegible]
63.73	64.56	65.60	[illegible]6.57	[illegible]	[illegible]
69.15	69.[illegible]	70.87	71.[illegible]	7[illegible]	[illegible]
74.92	75.52	76.05	77.[illegible]	78.[illegible]	[illegible]
79.68	80.40	80.97	[illegible]1.21	[illegible]	[illegible]

RL test 13

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.56	1.54	1.44	1.37	1.12	1.11
1.18	1.17	1.17	1.11	1.07	1.1
1.15	1.15	1.11	1.07	1.04	1.15
1.05	1.05	1.16	1.11	1.11	1.11
1.02	1.11	1.09	1.14	1.0	1.13
1.11	1.11	1.12	1.12	1.0	1.12
1.12	1.12	1.09	1.12	1.12	1.09
1.10	1.10	1.11	1.11	1.1	1.10
1.05	1.10	1.09	1.09	1.05	1.0
1.05	1.10	1.09	1.11	1.11	1.09
1.09	1.09	1.10	1.08	1.0	1.10
1.09	1.09	1.11	1.07	1.0	1.1
1.06	1.08	1.11	1.03	1.0	1.0
1.07	1.07	1.03	1.07	1.0	1.07
1.08	1.07	1.05	1.05	1.05	1.07

MEAN OF RMS= 1.09

TIME ON TARGET (SECS)

0.93	1.91	1.96	2.23	3.12	4.1
5.78	6.51	7.53	8.58	9.21	10.1
11.15	12.13	12.74	13.56	14.41	15.1
16.49	17.25	17.83	18.49	19.21	20.1
21.29	22.05	22.70	23.19	23.87	24.57
25.62	26.44	27.33	28.20	29.34	30.2
30.24	31.06	32.08	32.49	33.59	34.3
35.45	36.49	36.92	37.88	38.58	39.39
40.87	41.39	42.37	43.11	44.03	44.97
45.68	46.41	47.48	48.43	49.48	50.4
51.46	52.12	52.77	53.44	54.42	55.4
55.62	56.39	57.33	58.32	59.33	60.1
61.37	62.22	62.97	64.05	65.02	66.1
67.03	68.05	69.06	70.07	71.03	72.07
72.98	73.25	74.28	75.12	76.3	77.17

RL test 14

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.12	1.37	1.71	1.24	1.5[illegible]	[illegible]
1.11	1.24	1.05	1.21	1.[illegible]	[illegible]
1.15	1.11	1.07	[illegible]	1.14	[illegible]
1.14	1.06	1.13	[illegible]	1.11	[illegible]
0.94	1.04	1.02	1.07	1.0[illegible]	[illegible]
1.05	1.07	1.07	1.06	1.0[illegible]	[illegible]
1.06	1.06	1.05	1.0[illegible]	[illegible]	[illegible]
1.06	1.05	1.05	[illegible]	[illegible]	[illegible]
0.99	1.02	1.05	1.0[illegible]	1.04	[illegible]
1.01	1.03	1.02	1.[illegible]	1.0[illegible]	[illegible]
1.05	1.04	0.99	1.05	1.05	[illegible]
1.04	1.02	1.01	1.[illegible]	1.01	[illegible]
1.01	1.05	1.04	1.03	1.02	[illegible]
1.01	1.04	1.02	1.[illegible]	1.02	[illegible]
1.05	1.05	0.98	[illegible]	[illegible]	[illegible]

MEAN OF RMS= 1.05

TIME ON TARGET (SEC.)

0.95	0.[illegible]	1.46	2.[illegible]	[illegible]	[illegible]
4.95	[illegible]	[illegible]	7.[illegible]	[illegible]	[illegible]
10.9[illegible]	12.00	13.01	14.01	1[illegible]	[illegible]
16.23	17.06	18.04	19.[illegible]	[illegible]	[illegible]
22.10	23.14	24.14	[illegible]	[illegible]	[illegible]
27.60	28.27	29.23	30.24	31.[illegible]	[illegible]
33.12	34.05	35.09	[illegible]	37.1[illegible]	[illegible]
39.15	40.10	41.12	42.1[illegible]	43.12	[illegible]
44.66	45.54	[illegible]	47.[illegible]	[illegible]	[illegible]
49.86	50.87	51.91	52.[illegible]	[illegible]	[illegible]
55.69	56.62	57.64	[illegible]	[illegible]	[illegible]
61.04	[illegible]	62.63	[illegible]	64.65	[illegible]
66.[illegible]	67.32	68.22	[illegible]	7[illegible]	[illegible]
71.72	72.77	73.[illegible]	74.75	7[illegible]	[illegible]
77.77	78.75	79.40	[illegible]	[illegible]	[illegible]

SF test 1

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

2.47	2.22	1.69	1.34	1.[illegible]	.[illegible]
1.75	1.92	2.12	2.04	1.97	.[illegible]
1.92	1.98	1.90	1.[illegible]	1.[illegible]	.[illegible]
1.81	1.88	1.89	1.86	1.77	1.[illegible]
1.85	1.85	1.83	1.[illegible]	1.7[illegible]	.[illegible]
1.81	1.82	1.81	1.80	1.77	1.[illegible]
1.80	1.82	1.82	1.7[illegible]	1.7[illegible]	.[illegible]
1.79	1.77	1.83	1.[illegible]	1.7[illegible]	1.[illegible]
1.83	1.84	1.83	1.[illegible]	1.8[illegible]	1.[illegible]
1.80	1.77	1.83	1.[illegible]	1.8[illegible]	1.[illegible]
1.83	1.83	1.82	1.7[illegible]	1.78	.[illegible]
1.79	1.79	1.76	1.79	1.81	.[illegible]
1.84	1.85	1.81	1.8[illegible]	1.81	1.[illegible]
1.82	1.83	1.87	1.[illegible]	1.[illegible]	1.[illegible]
1.89	1.89	1.88	1.88	1.8[illegible]	.[illegible]

MEAN OF RMS= 1.83

TIME ON TARGET (SECS)

0.21	0.61	1.61	2.61	3.[illegible]	.[illegible]
4.49	4.73	4.66	5.31	5.5[illegible]	.[illegible]
6.76	7.24	7.75	9.04	10.0[illegible]	10.[illegible]
10.61	10.84	11.29	12.06	12.41	12.[illegible]
13.01	13.61	14.03	14.51	14.65	15.[illegible]
15.06	15.61	16.51	17.51	18.1[illegible]	1[illegible]
18.75	19.00	19.20	20.25	21.2[illegible]	21.[illegible]
21.75	22.12	22.16	22.[illegible]	23.87	23.[illegible]
24.22	24.48	25.47	2[illegible]	27.32	27.[illegible]
28.29	28.78	28.78	28.75	2[illegible]	2[illegible]
29.78	29.92	30.92	31.90	32.48	33.[illegible]
33.59	33.69	34.07	34.04	34.09	34.[illegible]
34.59	34.75	35.95	35.75	37.59	37.[illegible]
38.34	38.64	39.82	39.[illegible]	39.10	3[illegible]
39.55	40.62	40.28	41.17	41.36	41.[illegible]

SF test 2

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

2.04	2.03	2.00	1.97	1.96	1.95
1.77	1.79	1.75	1.72	1.67	1.63
1.67	1.65	1.64	1.64	1.63	1.63
1.60	1.55	1.62	1.56	1.54	1.50
1.48	1.49	1.52	1.54	1.47	1.47
1.46	1.49	1.55	1.55	1.51	1.50
1.49	1.56	1.56	1.56	1.53	1.54
1.57	1.57	1.57	1.59	1.58	1.56
1.53	1.57	1.56	1.56	1.52	1.51
1.57	1.56	1.56	1.54	1.54	1.56
1.54	1.54	1.55	1.55	1.52	1.51
1.52	1.51	1.50	1.49	1.50	1.49
1.50	1.50	1.51	1.51	1.50	1.49
1.49	1.51	1.50	1.51	1.51	1.50
1.49	1.51	1.50	1.51	1.50	1.51

MEAN OF RMS= 1.53

TIME ON TARGET (SECS)

0.01	0.20	0.69	1.43	2.31	3.13
3.64	3.69	4.36	4.73	5.76	6.75
7.85	8.18	8.81	9.56	10.16	11.19
11.65	12.04	12.16	12.79	13.33	14.09
15.53	16.08	16.15	16.93	17.71	18.15
18.76	18.83	19.16	19.73	20.71	21.13
21.55	21.52	22.30	22.82	23.48	23.13
23.60	23.72	24.02	24.39	24.54	24.81
25.82	25.99	27.40	27.54	28.58	29.40
29.60	30.14	30.46	31.43	32.56	33.45
34.52	35.20	35.27	35.74	36.94	37.75
38.52	38.94	39.29	39.79	40.43	41.02
41.42	41.61	41.93	42.78	43.97	43.57
44.39	44.38	44.77	45.13	46.23	47.06
47.45	47.81	47.95	48.15	49.11	49.72

SF test 3

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.39	1.46	1.53	1.61	1.48	1.43
1.36	1.32	1.31	1.33	1.28	1.33
1.41	1.33	1.39	1.[illegible]	1.2[illegible]	1.41
1.43	1.42	1.5[illegible]	1.[illegible]	1.[illegible]	1.47
1.56	1.58	1.57	1.[illegible]	1.56	1.40
1.44	1.44	1.5[illegible]	1.[illegible]	1.4[illegible]	1.44
1.41	1.41	1.40	1.[illegible]	1.42	1.57
1.41	1.41	1.40	1.41	1.41	1.41
1.41	1.41	1.40	1.[illegible]	1.40	1.[illegible]
1.42	1.40	1.[illegible]	1.[illegible]	1.40	1.41
1.43	1.40	1.42	1.41	1.41	1.42
1.43	1.42	1.41	1.[illegible]	1.[illegible]	1.41
1.40	1.41	1.3[illegible]	1.[illegible]	1.[illegible]	1.4[illegible]
1.39	1.39	1.3[illegible]	1.[illegible]	1.47	1.[illegible]

MEAN OF RMS= 1.39

TIME ON TARGET (SECS)

4.33	4.46	5.41	6.[illegible]	[illegible].54	7.1[illegible]
[illegible].[illegible]	[illegible].[illegible]	[illegible].[illegible]	[illegible].[illegible]	[illegible].[illegible]	10.1[illegible]
10.23	10.58	11.[illegible]	11.[illegible]	1[illegible].61	12.41
13.03	13.48	14.46	13.13	13.80	13.[illegible]
16.81	17.34	18.35	17.20	1[illegible].44	17.[illegible]
19.99	21.02	22.02	23.[illegible]	23.49	23.[illegible]
24.37	24.58	24.79	24.[illegible]	2[illegible].85	25.47
25.55	27.68	28.72	29.[illegible]	29.48	30.1[illegible]
30.26	31.25	32.30	33.34	34.0[illegible]	34.[illegible]
34.67	35.45	36.45	37.42	38.18	38.[illegible]
38.49	39.34	40.38	41.[illegible]	42.09	42.17
42.76	43.16	43.87	44.44	45.44	45.74
46.35	47.33	48.37	48.[illegible]	4[illegible].77	50.[illegible]
50.38	51.42	52.39	53.43	54.0[illegible]	54.[illegible]

SF test 4

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.18	1.36	1.28	1.21	1.11	1.20
1.13	1.22	1.37	1.27	1.23	1.17
1.19	1.24	1.16	1.15	1.06	1.15
1.15	1.11	1.11	1.15	1.15	1.15
1.21	1.14	1.12	1.12	1.08	1.1[illegible]
1.14	1.15	1.13	1.13	1.15	1.17
1.08	1.11	1.11	1.19	1.11	1.12
1.04	1.08	1.07	1.15	1.12	1.12
1.10	1.10	1.12	1.11	1.12	1.10
1.12	1.11	1.10	1.12	1.13	1.15
1.19	1.17	1.15	1.13	1.17	1.17
1.17	1.17	1.19	1.20	1.18	1.19
1.17	1.18	1.20	1.20	1.20	1.19
1.21	1.18	1.20	1.17	1.17	1.1[illegible]

MEAN OF RMS= 1.15

TIME ON TARGET (SECS)

1.03	1.95	2.85	3.80	4.81	5.85
6.03	6.81	7.19	7.98	8.21	9.11
10.23	10.80	10.81	11.[illegible]	12.64	13.71
14.75	15.43	16.31	17.[illegible]	17.63	18.54
19.43	20.39	21.37	22.15	23.52	24.27
25.38	24.43	25.55	26.34	28.69	27.5[illegible]
27.62	28.12	28.93	29.[illegible]0	30.94	31.97
32.93	33.97	34.94	35.77	36.65	37.57
38.43	38.82	39.57	40.[illegible]3	41.2[illegible]	42.24
43.27	43.37	44.31	44.[illegible]2	45.24	46.[illegible]
46.31	46.33	46.93	47.[illegible]7	47.26	48.38
49.23	49.24	50.08	50.47	51.95	52.[illegible]
52.94	53.39	53.85	54.47	55.[illegible]	56.2[illegible]
57.21	57.86	57.86	58.[illegible]4	59.[illegible]	60.[illegible]
61.47	62.[illegible]	62.[illegible]	64.[illegible]	64.[illegible]	65.[illegible]

SF test 5

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

[illegible]	[illegible]	2.23	[illegible]	[illegible]	[illegible]
2.10	2.45	2.41	2.14	[illegible]	[illegible]
2.27	2.20	2.19	[illegible]	[illegible]	[illegible]
2.05	2.14	2.09	[illegible]	2.10	[illegible]
2.11	2.08	2.09	2.05	2.04	[illegible]
2.01	2.03	2.03	[illegible]	1.94	[illegible]
1.99	1.97	1.96	[illegible]	[illegible]	[illegible]
2.05	2.13	2.12	2.11	2.12	[illegible]
2.07	2.06	2.05	[illegible]	[illegible]	[illegible]
2.01	2.03	2.03	[illegible]	2.06	[illegible]
2.04	2.05	2.03	[illegible]	2.02	[illegible]
2.04	2.03	2.03	[illegible]	2.02	2.13
2.16	2.16	2.15	[illegible]	2.12	[illegible]
2.14	2.15	2.14	2.12	2.19	2.12
2.13	2.11	2.09	[illegible]	[illegible]	[illegible]

MEAN OF RMS= 2.03

TIME ON TARGET (SECS)

0.1[illegible]	1.03	1.93	[illegible]	[illegible]	[illegible]
3.36	3.40	4.34	[illegible]	[illegible]	[illegible]
5.16	6.81	6.89	[illegible]	[illegible]	[illegible]
[illegible]	9.26	[illegible]	[illegible]	[illegible]	[illegible]
10.54	11.55	11.75	[illegible]	[illegible]	[illegible]
14.01	14.56	15.58	[illegible]	[illegible]	[illegible]
18.46	19.41	19.41	[illegible]	[illegible]	[illegible]
20.72	20.72	21.27	[illegible]	[illegible]	[illegible]
23.54	23.89	24.72	[illegible]	[illegible]	[illegible]
26.43	26.50	27.27	[illegible]	[illegible]	[illegible]
29.35	29.84	30.85	[illegible]	[illegible]	[illegible]
32.60	33.13	33.72	[illegible]	[illegible]	[illegible]
34.97	35.38	36.08	[illegible]	[illegible]	[illegible]
37.56	37.74	38.83	[illegible]	[illegible]	[illegible]
41.14	42.14	43.11	[illegible]	44.11	44.17

SF test 6

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

[illegible]	2.09	1.8[illegible]	1.[illegible]7	1.7	[illegible]
1.6[illegible]	1.62	1.70	1.[illegible]1	1.54	1.6[illegible]
1.54	1.76	1.72	1.71	1.64	[illegible]
1.57	1.61	1.68	[illegible]	1.66	1.63
1.6[illegible]	1.67	1.57	[illegible]	1.6[illegible]	[illegible]
1.51	1.60	1.55	[illegible]	1.62	1.60
1.61	1.61	1.61	[illegible]	1.5[illegible]	[illegible]
1.58	1.53	1.59	[illegible]	1.59	[illegible]
1.61	1.59	1.58	[illegible]	1.56	[illegible]
1.55	1.59	1.63	[illegible]	1.60	[illegible]
1.56	1.56	1.56	1.[illegible]7	1.5[illegible]	1.[illegible]7
1.55	1.57	1.53	[illegible]	1.5[illegible]	[illegible]
1.51	1.51	1.51	[illegible]	[illegible]	1.4[illegible]
1.49	1.49	1.49	1.50	1.4[illegible]	1.4[illegible]
1.4[illegible]	1.47	1.48	[illegible]	1.4[illegible]	[illegible]

MEAN OF RMS= 1.57

TIME ON TARGET (SECS)

0.46	1.14	1.88	[illegible]	[illegible]	[illegible]
4.20	4.66	4.66	[illegible]	[illegible]	7.[illegible]
7.49	7.99	8.88	[illegible]	10.5[illegible]	[illegible]
11.9[illegible]	12.31	12.58	13.[illegible]	[illegible]	[illegible]
14.4[illegible]	14.88	15.76	16.[illegible]	17.56	[illegible]
19.11	19.41	19.86	[illegible]	[illegible]	21.7[illegible]
21.97	22.58	23.60	[illegible]	24.92	[illegible]
26.40	26.85	26.86	27.[illegible]	27.57	[illegible]
28.49	28.79	29.09	30.07	30.75	31.[illegible]
32.57	32.92	32.90	33.[illegible]	34.50	[illegible]
35.87	36.88	37.55	37.[illegible]	[illegible].47	[illegible]
40.24	40.65	41.66	42.[illegible]	43.71	44.[illegible]
44.89	45.52	46.61	47.1[illegible]	48.08	49.1[illegible]
50.0[illegible]	50.64	51.22	51.[illegible]	51.96	[illegible]
53.51	54.16	55.18	55.[illegible]7	[illegible]	56.5[illegible]

SF test 7

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

2.05	2.19	2.49	2.44	2.51	2.44
2.66	2.77	2.63	2.[illegible]	2.66	2.[illegible]
2.50	2.55	2.51	2.51	2.52	2.[illegible]
2.61	2.77	2.71	2.71	2.67	2.[illegible]
2.[illegible]	2.77	2.79	2.[illegible]	2.[illegible]	2.[illegible]
2.75	2.78	2.75	2.[illegible]	2.[illegible]	2.[illegible]
2.[illegible]	2.[illegible]	2.[illegible]	2.[illegible]	2.[illegible]	2.[illegible]
2.87	2.86	2.86	2.[illegible]	2.[illegible]	2.[illegible]
2.[illegible]	2.75	2.77	2.76	2.77	2.[illegible]
2.75	2.76	2.76	2.[illegible]	2.[illegible]	2.[illegible]
2.71	2.71	2.71	2.[illegible]	2.[illegible]	2.[illegible]
2.80	2.[illegible]	2.[illegible]	2.[illegible]	2.[illegible]	2.[illegible]
2.[illegible]	2.[illegible]	2.[illegible]	2.[illegible]	2.[illegible]	2.[illegible]
2.75	2.74	2.73	2.71	2.71	2.[illegible]

MEAN OF RMS= 2.71

TIME ON TARGET (SECS)

0.01	0.70	1.[illegible]	1.[illegible]	2.[illegible]	2.[illegible]
2.75	2.96	2.96	3.[illegible]	3.41	3.[illegible]
5.[illegible]	5.[illegible]	5.[illegible]	6.[illegible]	6.[illegible]	7.14
7.56	7.68	8.05	8.[illegible]	8.30	8.[illegible]
8.51	8.58	9.15	9.19	10.19	10.[illegible]
10.94	10.96	10.94	11.[illegible]	11.58	11.71
11.75	12.18	12.18	12.18	12.41	13.[illegible]
13.58	13.61	13.61	13.[illegible]	13.9[illegible]	14.01
14.[illegible]	14.[illegible]	15.[illegible]	15.[illegible]	15.[illegible]	15.[illegible]
16.90	17.29	17.51	17.[illegible]	17.6[illegible]	17.[illegible]
17.[illegible]	19.03	19.[illegible]	19.[illegible]	20.[illegible]	20.[illegible]
21.54	21.29	22.03	22.[illegible]	22.[illegible]	22.[illegible]
23.25	23.22	23.[illegible]	24.05	24.[illegible]	24.[illegible]
24.[illegible]	25.08	25.[illegible]	26.12	26.[illegible]	26.[illegible]
28.[illegible]	27.[illegible]	28.[illegible]	28.[illegible]	29.[illegible]	29.[illegible]

SF test 8

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

2.34	2.46	2.41	2.41	2.27	2.32
2.25	2.40	2.53	2.[illegible]	2.37	2.34
2.26	2.28	2.37	2.35	2.28	2.30
2.29	2.29	2.36	2.32	2.29	2.31
2.32	2.28	2.28	2.30	2.41	2.41
2.42	2.44	2.44	2.40	2.38	2.36
2.35	2.37	2.37	2.35	2.35	2.38
2.31	2.36	2.41	2.41	2.39	2.[illegible]
2.38	2.34	2.36	2.34	2.33	2.32
2.36	2.37	2.37	2.35	2.34	2.33
2.34	2.33	2.31	2.30	2.29	2.30
2.2[illegible]	2.33	2.32	2.[illegible]	2.33	2.[illegible]
2.32	2.32	2.33	2.32	2.31	2.30
2.29	2.34	2.36	2.[illegible]	2.34	2.34

MEAN OF RMS=2.34

TIME ON TARGET (SECS)

0.00	0.28	0.51	0.84	1.31	2.[illegible]
2.91	5.05	5.36	5.30	6.05	6.71
6.78	6.01	6.05	6.98	7.01	7.[illegible]
7.55	7.86	8.01	8.[illegible]	8.53	8.54
8.89	9.20	9.18	9.[illegible]	10.89	10.81
11.29	11.81	11.99	12.[illegible]	12.18	12.[illegible]
12.53	12.61	13.05	13.41	14.21	15.01
15.30	15.30	15.81	16.[illegible]	17.30	1[illegible]
18.50	18.66	18.70	19.29	20.09	20.18
20.45	20.92	21.32	21.[illegible]	22.57	22.7[illegible]
22.89	23.15	23.18	24.05	25.08	25.19
25.69	25.97	26.30	26.75	27.06	27.53
27.74	27.70	27.95	27.97	27.97	28.97
28.83	28.80	29.27	29.[illegible]7	29.87	30.[illegible]7
30.47	30.98	31.03	32.1[illegible]	32.62	32.95

SF test 9

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

0.00	1.76	0.91	1.77	1.67	1.54
1.57	1.42	1.52	1.72	1.63	1.67
1.71	1.73	1.70	1.69	1.57	1.64
1.61	1.65	1.78	1.76	1.79	1.73
1.69	1.69	1.74	1.69	1.69	1.69
1.72	1.68	1.68	1.77	1.75	1.74
1.70	1.68	1.65	1.69	1.70	1.67
1.69	1.69	1.70	1.72	1.70	1.68
1.68	1.65	1.67	1.68	1.67	1.67
1.66	1.66	1.72	1.72	1.72	1.72
1.70	1.71	1.70	1.71	1.66	1.67
1.71	1.71	1.72	1.72	1.71	1.71
1.70	1.69	1.69	1.71	1.71	1.67
1.65	1.68	1.69	1.75	1.71	1.71
1.71	1.72	1.73	1.70	1.71	1.70

MEAN OF RMS= 1.69

TIME ON TARGET (SECS)

0.45	1.95	1.45	1.78	2.70	3.45
5.75	4.31	4.75	4.75	5.15	5.09
6.70	7.11	7.25	8.09	8.40	9.55
9.83	10.19	10.21	10.34	11.91	12.41
13.95	14.75	14.71	15.19	15.58	16.11
16.59	17.28	17.59	17.90	18.15	19.11
20.10	21.17	21.42	21.92	22.52	23.48
23.48	24.07	24.67	24.45	25.37	25.54
27.39	28.38	28.72	29.05	30.08	30.29
30.70	31.15	31.19	31.95	32.44	32.92
33.62	33.99	34.57	35.09	36.60	37.30
38.05	38.05	38.50	38.99	39.17	40.21
41.18	41.33	41.91	42.25	43.05	43.57
44.12	44.58	44.99	45.01	45.95	46.46
46.48	47.04	48.02	48.17	49.29	50.52

SF test 10

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

2.51	2.56	2.19	[illegible]	[illegible]	[illegible]
1.93	1.93	1.86	[illegible]	[illegible]	[illegible]
1.71	1.70	1.64	[illegible]	[illegible]	[illegible]
1.63	1.66	1.66	[illegible]	[illegible]	[illegible]
1.62	1.61	1.62	[illegible]	[illegible]	[illegible]
1.54	1.59	1.57	[illegible]	[illegible]	[illegible]
1.44	1.48	1.45	[illegible]	[illegible]	[illegible]
1.40	1.44	1.44	[illegible]	[illegible]	[illegible]
1.40	1.42	1.40	[illegible]	[illegible]	[illegible]
1.51	1.51	1.50	[illegible]	[illegible]	[illegible]
1.47	1.47	1.46	[illegible]	[illegible]	[illegible]
1.44	1.46	1.44	[illegible]	[illegible]	[illegible]
1.43	1.42	1.41	[illegible]	[illegible]	[illegible]
1.40	1.42	1.41	[illegible]	[illegible]	[illegible]

MEAN OF RMS= 1.54

TIME ON TARGET (SECS)

0.23	0.33	0.34	[illegible]	[illegible]	[illegible]
3.53	3.28	3.76	[illegible]	[illegible]	[illegible]
7.55	8.33	9.35	[illegible]	[illegible]	[illegible]
13.43	13.95	14.76	[illegible]	[illegible]	[illegible]
16.85	17.20	17.61	[illegible]	[illegible]	[illegible]
20.53	21.58	21.72	[illegible]	[illegible]	[illegible]
25.04	25.99	27.02	[illegible]	[illegible]	[illegible]
31.02	32.12	32.54	[illegible]	[illegible]	[illegible]
35.95	36.20	36.80	[illegible]	[illegible]	[illegible]
40.64	41.23	41.52	[illegible]	[illegible]	[illegible]
42.62	43.43	44.42	[illegible]	[illegible]	[illegible]
46.07	48.78	49.26	[illegible]	[illegible]	[illegible]
52.62	53.79	53.91	[illegible]	[illegible]	[illegible]
57.53	58.54	59.08	[illegible]	[illegible]	[illegible]
62.95	62.75	63.41	[illegible]	[illegible]	[illegible]

SF test 11

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

1.39	1.37	1.44	1.42	1.41	1.41
1.45	1.43	1.46	1.46	1.47	1.47
1.51	1.49	1.53	1.54	1.50	1.50
1.44	1.43	1.47	1.44	1.46	1.41
1.43	1.39	1.43	1.40	1.44	1.41
1.39	1.37	1.42	1.42	1.41	1.43
1.43	1.41	1.40	1.44	1.39	1.39
1.37	1.40	1.38	1.38	1.37	1.40
1.41	1.39	1.38	1.36	1.38	1.35
1.35	1.33	1.36	1.38	1.32	1.34
1.35	1.34	1.34	1.39	1.36	1.34
1.36	1.36	1.38	1.37	1.33	1.37
1.36	1.37	1.35	1.34	1.35	1.34
1.33	1.34	1.32	1.32	1.33	1.34

MEAN OF RMS= 1.39

TIME ON TARGET (SECS)

0.74	1.51	2.15	3.15	4.13	5.15
4.55	5.56	6.61	7.63	8.65	9.67
10.15	11.11	11.14	11.41	11.91	12.14
12.51	13.48	14.54	15.55	15.91	16.75
17.49	18.11	18.85	19.68	20.70	20.94
21.25	22.28	23.24	23.54	24.13	25.14
25.42	26.03	26.02	26.54	27.12	27.14
28.17	29.19	30.12	31.08	31.38	32.15
33.33	34.32	34.85	34.14	35.12	35.42
36.12	37.12	38.12	39.34	40.64	41.37
42.05	42.28	43.17	44.18	45.13	45.17
46.06	47.02	48.04	48.41	49.74	49.92
49.52	49.99	50.54	51.43	52.51	52.93
53.02	54.18	55.22	56.15	56.88	57.14
58.89	59.97	60.02	61.15	62.01	62.15

SF test 12

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2.02	1.65	1.76	[illegible]	1.55	[illegible]
1.57	1.57	1.60	[illegible]	1.52	[illegible]
1.42	1.43	1.41	1.44	1.37	[illegible]
1.39	1.41	1.39	[illegible]	1.40	[illegible]
1.35	1.35	1.35	[illegible]	1.34	[illegible]
1.28	1.36	1.33	[illegible]	1.30	[illegible]
1.28	1.26	1.30	[illegible]	1.28	[illegible]
1.27	1.24	1.24	[illegible]	1.24	[illegible]
1.24	1.25	1.29	[illegible]	1.24	[illegible]
1.23	1.21	1.24	[illegible]	1.23	[illegible]
1.24	1.25	1.25	[illegible]	1.24	[illegible]
1.22	1.23	1.22	[illegible]	1.25	[illegible]
1.21	1.20	1.23	[illegible]	1.21	[illegible]
1.21	1.22	1.23	[illegible]	1.20	[illegible]

MEAN OF RMS= 1.30

TIME ON TARGET (SECS)

0.08	0.51	1.38	2.59	3.58	[illegible]
[illegible]	5.88	6.81	7.75	[illegible]	[illegible]
10.74	10.88	11.10	[illegible]	[illegible]	[illegible]
14.81	15.85	16.88	[illegible]	[illegible]	[illegible]
20.25	20.64	21.59	[illegible]	[illegible]	24.17
24.77	25.80	26.80	[illegible]	[illegible]	[illegible]
29.62	29.59	30.55	[illegible]	[illegible]	[illegible]
34.60	35.63	36.63	[illegible]	[illegible]	[illegible]
40.48	41.05	42.06	[illegible]	[illegible]	[illegible]
44.61	45.42	46.42	[illegible]	[illegible]	49.47
49.72	50.61	51.52	[illegible]	[illegible]	[illegible]
54.27	55.27	55.99	[illegible]	[illegible]	[illegible]
60.07	61.03	61.32	[illegible]	[illegible]	[illegible]
64.22	65.25	65.30	[illegible]	[illegible]	[illegible]
69.15	69.20	69.62	[illegible]	[illegible]	[illegible]

SF test 13

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

2.27	2.15	2.10	1.9	1.9	1.9
1.74	1.75	1.8	1.8	1.8	1.8
1.55	1.55	1.54	1.5	1.52	1.5
1.59	1.65	1.65	1.6	1.62	1.6
1.55	1.54	1.50	1.51	1.5	1.51
1.47	1.47	1.46	1.4	1.4	1.44
1.44	1.44	1.43	1.43	1.44	1.43
1.44	1.42	1.44	1.42	1.41	1.42
1.41	1.40	1.40	1.42	1.41	1.41
1.37	1.39	1.38	1.4	1.37	1.41
1.34	1.37	1.36	1.34	1.35	1.33
1.35	1.36	1.35	1.34	1.34	1.34
1.34	1.31	1.31	1.33	1.3	1.32
1.33	1.33	1.33	1.32	1.34	1.3

MEAN OF RMS= 1.45

TIME ON TARGET (SECS)

4.89	5.88	6.85	7.8	8.8	9.8
10.88	11.88	12.44	13.41	14.34	15.4
16.25	17.29	17.91	18.9	19.93	20.97
21.81	20.21	20.92	21.9	22.94	23.97
24.78	24.78	25.67	26.7	27.17	27.8
28.37	29.33	30.28	31.3	31.32	32.34
33.32	34.34	35.22	35.3	36.3	37.3
38.00	38.38	39.32	40.32	41.17	41.17
42.23	43.29	44.21	44.3	45.3	46.31
47.32	48.37	49.19	49.19	50.32	51.3
52.31	53.32	54.94	55.19	57.34	57.3
57.32	58.37	59.39	60.19	61.38	62.4
63.43	64.35	64.77	64.78	65.5	66.3
67.08	67.66	67.66	68.18	68.17	70.31

SP test 14

ROLL
SUM OF SINE WAVES FUNCTION

RMS VALUE OF ERROR

[illegible]	0.00	1.44	[illegible]	1.11	1.23
1.35	1.18	1.17	1.13	1.1[illegible]	1.[illegible]
1.07	1.11	1.11	1.[illegible]1	1.11	1.1[illegible]
1.14	1.29	1.14	1.1[illegible]	1.1[illegible]	1.1
1.07	1.09	1.09	0.[illegible]	1.0[illegible]	1.1[illegible]
1.11	1.09	1.08	1.[illegible]0	1.0[illegible]	1.1[illegible]
1.0[illegible]	1.10	1.07	1.11	1.08	1.1[illegible]
1.1[illegible]	1.09	1.07	1.[illegible]	1.0[illegible]	1.[illegible]
1.0[illegible]	1.06	1.07	1.11	1.10	1.0[illegible]
1.09	1.08	1.09	1.[illegible]	1.07	1.11
1.0[illegible]	1.11	1.1[illegible]	[illegible]	1.10	1.1[illegible]
1.10	1.10	1.1[illegible]	1.1[illegible]	1.1[illegible]	1.11
1.11	1.12	1.12	1.1[illegible]	1.11	1.11
1.11	1.16	1.1[illegible]	1.11	1.12	1.1[illegible]
1.1[illegible]	1.12	1.11	1.11		

MEAN OF RMS= 1.10

TIME ON TARGET (SECS)

0.[illegible]	1.98	2.[illegible]	2.[illegible]	3.[illegible]	4.[illegible]
5.[illegible]	6.[illegible]9	7.08	7.[illegible]	[illegible].[illegible]	[illegible].[illegible]
10.[illegible]	11.41	12.[illegible]	13.[illegible]	14.0[illegible]	[illegible].11
19.[illegible]	16.[illegible]5	17.60	18.[illegible]	[illegible].[illegible]	[illegible].[illegible]
21.12	21.84	22.24	23.[illegible]	[illegible].24	[illegible].[illegible]
26.23	27.28	28.28	29.[illegible]	30.0[illegible]	30.[illegible]
31.92	32.97	33.39	34.[illegible]	35.0[illegible]	[illegible].[illegible]
37.09	38.12	39.10	40.[illegible]	41.14	41.[illegible]
42.[illegible]	43.[illegible]	43.[illegible]	44.[illegible]	45.32	45.[illegible]
47.24	48.27	49.27	50.[illegible]	50.72	51.7[illegible]
52.78	53.26	53.67	54.[illegible]	55.11	55.77
57.[illegible]	57.04	58.06	58.[illegible]	58.[illegible]	[illegible].[illegible]
60.14	60.52	60.76	61.[illegible]	62.77	[illegible].[illegible]
64.32	65.87	66.87	67.[illegible]	6[illegible].90	[illegible].
70.[illegible]	71.[illegible]	71.[illegible]	72.[illegible]	73.[illegible]	74.41

Vita

Nathan H. Krys was born November 17, 1947 in Munich, West Germany. His family immigrated to the United States on January 6, 1950 and settled in New York City. He graduated from Brooklyn Technical High School in 1965, and later attended the Academy of Aeronautics in Queens, New York. There he received an Associate Degree in Electronic Technology in January of 1968. After a short employment with Western Electric, he enlisted in the Air Force in November of 1968 and was later assigned to Forbes AFB, Kansas. He met and later married the former Leslie J. O'Reilly, of Topeka, Kansas, on November 28, 1971. Selected for the Airman Education and Commissioning Program, he attended the University of Wyoming where he received a Bachelor of Science degree in Electrical Engineering in June of 1974. After completion of Officer Training School, he received his commission in September of 1974. He later completed navigator training school at Mather AFB, California and received his wings in May of 1975. During subsequent flying assignments he flew C-141's at McGuire AFB, WC-130's at Anderson AFB, and HC-130's at McClellan AFB. In June of 1981 he entered the School of Engineering, Air Force Institute of Technology.

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Longitudinal simulation
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

An analog computer simulation was used to model the roll dynamics of the generic aircraft which had been evaluated on the variable stability NT-33A aircraft. Sum of sine waves and random step functions were used as the two different command signals. The purpose of this study was to determine what effect the nature of the command signal had on the pilot rating of the

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task simulation.

The experiments consisted of fourteen different tests for each command signal. Five pilots, with varied flying experience, were instructed to follow the command signal in a pursuit flying task. The system time delay was varied from 0.1 to 0.8 seconds. The highest frequency component of the input signal was 2.54 radians/second. The subjects used a control stick while looking at an oscilloscope displaying the command signal and the subject's response. RMS error, time on target, and the Cooper-Harper rating scale were used as performance measures.

The experiments showed that the subjects considered the sum of sine waves task closer to an actual flyingtask. In addition, as the time delay was decreased, the subjects preferred K/s-like dynamics.

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